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THE DEVELOPMENT OF DIFFERENTIATION AND CONSERVATION OF NUMBER.

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EARLY FORMS OF NUMERICAL REASONING WERE INVESTIGATED BY EXAMINING THE ROLE OF A SET OF VARIABLES IN THE DEVELOPMENT OF CONSERVATION OF NUMBER. CONSERVATION OF NUMBER WAS DEFINED AS THE RECOGNITION THAT THE NUMBER OF OBJECTS CONSTITUTES AN AGGREGATE WHICH IS NOT CHANGED MERELY BY REARRANGING THEM. EXPERIMENT ONE WAS CONDUCTED WITH CHILDREN FROM DIVERSE SCHOOL BACKGROUNDS. THREE GROUPS OF BOYS FROM THE KINDERGARTEN AND FIRST-GRADE LEVELS WERE STUDIED. THERE WERE 24 SUBJECTS IN THE 3 KINDERGARTEN GROUPS WHO RANGED IN AGE FROM 5.3 TO 6.3 YEARS, AND THE FIRST-GRADE SUBJECT AGES WERE 6.3 TO 7.3 YEARS. EXPERIMENT 2 HAD 98 SUBJECTS FROM THE FIRST-GRADE CLASSES OF 2 PUBLIC SCHOOLS IN A MIDDLE-CLASS NEIGHBORHOOD CURRENTLY DETERIORATING. CONSERVATION MATERIALS CONSISTED OF MINIATURE TRUCKS AND BLOCKS OF VARYING SIZE, SHAPE, AND COLOR. THE NUMBER AND QUALITY OF THESE OBJECTS WERE DETERMINED BY THE EXPERIMENTAL CONDITIONS IN WHICH THEY WERE EMPLOYED. IT WAS HYPOTHESIZED THAT THE ABILITY TO DISTINGUISH BETWEEN SPATIAL AND NUMERICAL CUES IS SALIENT TO EFFECTIVE FUNCTIONING. IN GENERAL, EVIDENCE SEEMED TO INDICATE THESE EXPECTATIONS WERE CONFIRMED, BUT THE CORRELATIONS BETWEEN VARIOUS MEASURES OF DIFFERENTIATION AND CONSERVATION OF NUMBER TENDED TO BE LOW. THE REPORT CONCLUDED THAT IT IS THE ORGANIZING AND INTEGRATING ASPECT OF COGNITION WHICH NEEDS TO BE DELINEATED IF COMPLEX FORMS OF BEHAVIOR ARE TO BE UNDERSTOOD. (HB)

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THE DEVELOPMENT OF DIFFERENTIATION
AND CONSERVATION OF NUMBER

Cooperative Research Project No. 2270

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Bank Street College of Education

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education

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AND CONSERVATION OF NUMBER**

Cooperative Research Project No. 2270

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INTRODUCTION

In the present study some early forms of numerical reasoning have been investigated by examining the role of a set of variables in the development of conservation of number. Conservation of number refers to a mode of thinking about reality, a logical attitude which recognizes that the number of objects constituting an aggregate is not changed merely by rearranging them. The experimental paradigm most frequently used to measure conservation of number is: 1) presentation to S of two groups of objects of equal number arranged in parallel rows of equal length, 2) the subsequent outward (or inward) displacement of the objects in one row so as to increase (or decrease) its length relative to the other without changing the actual number of objects, and 3) determination of whether this spatial rearrangement affects S's judgment of the relative number of objects in each row.

The concept of conservation of number was originally formulated by Piaget (1952), who also developed methods for its assessment. He has regarded conservation of number as signaling the onset of logical reasoning; the ability to conserve number indicated the presence of an operational mode of cognition -- the ability to deal with reality in representational terms. The child begins to utilize interrelationships among past events to organize and direct current behavior, his response no longer principally governed by cues emitted by the contemporaneous stimulus. As various forms of conservation unfold, they illuminate, for Piaget, the child's cognitive development. At an early age the child learns that objects and people are permanent, that they have an existence apart from the moments when they are directly sensed. Later he recognizes the property of permanence in more abstract entities. He begins to conserve number, weight, substance; he gradually recognizes their

immutability in the face of changes in irrelevant cues such as length and shape.

On the basis of his experiments, Piaget concluded that there are three stages in the development of conservation. The first stage is characterized by a form of quantitative equivalence which is recognized only when the correspondence between elements is actually perceived. If one set of objects is redistributed so that the visual cues for their correspondence with the other set have been eliminated, their equivalence ceases to exist. In the second stage there is preservation of equivalence, provided that the geometric redistribution of elements is not very great. In the final stage of full and lasting conservation, equivalence is immediately apprehended, irrespective of the nature of the conflicting perceptual cues.

This transition from a perceptual to an operational viewpoint was seen by Piaget as mediated by two factors: 1) the development of a multidimensional character of thinking -- the ability to think in terms of two dimensions simultaneously, to coordinate two dimensions at once so that, for example, in the conservation of fluids, there is an awareness that a change in height is compensated for by a change in width of containers, and 2) the partition of material into equal units, e.g., the perception of the quantity of liquid as a composite of a number of basic equal units.

Piaget's theoretical formulations and experimentation have stimulated a large number of studies. Some have been concerned merely with confirming the age levels he found to be associated with the various stages of the development of conservation (Estes, 1956; Elkind, 1961a, b). Dodwell (1960, 1962, 1963) and Hood (1962) have examined the role of IQ in conservation performance, and Wohlwill (1960b), employing a scalogram analysis, attempted to

determine the place of conservation in the sequence of development of a set of related problems involving early phases of number concept development. More recently, experimental interest has focussed on the processes which mediate conservation by studying the comparative effectiveness of methods for training children who fail to manifest conservation ability. Smadelund (1961a, b, c, d, e), Wohlwill and Lowe (1962), Wallach and Spratt (1964), Beilin (1962, 1964, 1965 in press), and Sigel and Roper (1965) have conducted studies in which they attempted to identify the cognitive processes underlying effective procedures for training non-conservers.

The present study was concerned with delineating the process of conservation and identifying some of its antecedents and earlier developmental stages. Piaget's emphasis upon the development of multidimensional thinking and the awareness of partition of material into equal units as decisive cognitive determinants of conservation, appears incomplete and inaccurate. Instead, this study has focussed on the following set of factors: the differentiation ability of children, i.e., their ability to discriminate among magnitudes and various modes of classification; the stimulus characteristics of the aggregates to be judged, i.e., their significance, amount, and homogeneity; and finally a variable involving affect, i.e., tolerance for delay of gratification.

As the child develops, he forms new methods of differentiating the environment; these result in judgments of bigger, older, heavier, more, better, and so forth. The exact referents of these judgments are not at first completely clear to the child; they are progressively understood with greater clarity as he grows older. This leads to a number of questions: What are the circumstances which lead to the differentiation of aggregates in terms of numerosity as well as other magnitudes? What are the skills and experiences,

both cognitive and affective, which make this form of differentiation possible? What are the characteristics of aggregates which facilitate the mastery of distinctions with respect to number and what are the stages in the development of this ability? A more detailed consideration of the central variables which were investigated in the present study is given in the following section:

Central Issues of the Study

1. Is the degree of differentiation with respect to number related to differentiation of:

- a) other, non-numerical magnitudes, e.g., height, size, age
- b) parts of the self (body)
- c) non-magnitudinal aspects of the environment

If the development of number concept is to be regarded primarily as an advance in the level of differentiation among magnitudes, it may be expected to be related to the degree of differentiation of other magnitudes as well. Insofar as the differentiation of magnitudes represents a specific feature of a more general pattern of differentiating the environment, the level of number concept may also be expected to be related to non-magnitudinal aspects of differentiation of the environment. Moreover, since the first differentiation presumably occurs with respect to the self, and the degree of self-differentiation is considered by some theorists as the precursor to differentiation of the environment, there should be a substantial relationship between self-differentiation and differentiation of numerosity.

2. Does the size of the aggregate affect conservation of number, does conservation develop for numbers intuitively and immediately grasped before it develops for larger aggregates? Piaget's studies were conducted with aggregates exceeding five, numbers which young children cannot immediately

recognize or with which they have no intimate familiarity. It is to be expected that the child's more recently acquired concepts involving larger numbers, would be tenuously held, that numerosity would succumb when placed in competition with other magnitudes (e.g., length) which have been experimented with and understood for much longer periods of time. The question then arises whether the more established, immediately grasped numbers are supported by a more stable concept of conservation.

3. How important is the homogeneity of members of an aggregate in the determination of its numerosity? None of the studies of conservation have explored this variable; they have uniformly employed homogeneous aggregates. Although Piaget postulated that the concept of partition into equal units is an essential step in the development of conservation, one may conjecture that the comparison of equivalent numbers of aggregates whose component parts differ in size or some other attribute, may reduce some of the confusion of number with length or density of the aggregates. The use of homogeneous members of an aggregate in counting detracts attention from their individuality, from their wholeness, and therefore, it may be contested, interferes with their countability. On the other hand, heterogeneity of members may so encourage the apprehension of individuality that the objects cease to be regarded as an aggregate possessing numerosity. An alternative condition, occupying an intermediate point on the homogeneity-heterogeneity continuum, is one in which the members of one aggregate are homogeneous but different from an aggregate of equivalent number whose members are also homogeneous. It may be speculated that such a condition leads to maximal conservation because the homogeneity within aggregates does not distract the child from its numerosity, and the difference between aggregates discourages the establishment of their equivalence on a non-numerical basis.

4. Are conservation of equivalence and conservation of difference tasks of comparable difficulty? Piaget, in his experimental work, has focussed on the conservation of equivalence. But preservation of differences, the permanence of a difference between two numerical aggregates, irrespective of their spatial redistribution, is also a form of conservation. There is evidence, from Piaget's own work with conservation, although not explicitly cited by him, as well as from the standardization of the Stanford-Binet items and other tests, that children are more aware of differences than they are of similarities. It is possible that some of the instability of conservation which Piaget reports in the earlier stages of conservation among his Ss may be attributable to the sensitivity of his Ss to differences, to the more compelling quality of differences in stimuli as opposed to sameness. While conservation of equivalence represents a valid basis for distinguishing between "true" conservation, as Piaget calls it, and a more primitive stage, investigation of conservation of differences may help to further distinguish among earlier stages of conservation, where conservation of equivalences is incomplete. Instead of grouping all such incomplete forms together, if conservation of differences develops first, a further distinction, i.e., that between complete and incomplete conservation of differences, may thus be identified.

5. To what degree is differentiation of number related to the amount of investment in the objects involved? There is little question that differentiation of number does not develop simultaneously with respect to all phenomena. Certain objects lend themselves more readily to numerical differentiation, partly in terms of their physical properties, and partly because there is a practical need to differentiate these particular objects with respect to number. Yet much of the work investigating conservation of number

has been concerned with neutral objects, with relatively meaningless, insignificant stimuli. Insofar as number concept develops first in relation to and is applied to significant objects in the environment -- prized possessions, e.g., parts of the body, favored toys, a study of conservation in terms of impersonal geometric figures or beads (of no great significance for the child) may not succeed in eliciting less fully developed concepts of conservation which may nevertheless be present. Or conversely, it may be that neutral objects facilitate a more remote, more abstract attitude. A study of numerical differentiation based upon significant as compared with neutral objects would serve to delineate further the levels of number concept in children.

6. What are the major antecedents to individual differences in the development of number concept? Is the development of number concept fundamentally a matter of maturation, or are there important experiential antecedents to quantitative thinking? The role of the ability to postpone gratification in the development of thinking was brought into focus by Freud (1911) when he postulated that the introduction of a delay between the onset of a stimulus and the response to it, marked the beginning of ego functioning. An analogous concept has been introduced by Piaget in his description of the basic element in the development of conservation as the transition from a perceptual to an operational frame of reference. He thus singled out the child's capacity to respond to other than the cues of the immediate stimulus as a determinant of his judgment of number. Both theorists, then have emphasized the child's liberation from the demands of the immediate stimulus situations -- Freud, at the level of impulse gratification, Piaget, at the level of cognitive functioning. These theoretical speculations point to the tolerance for delay in gratification as an important forerunner of the

development of reasoning ability. They suggest that conservation of number, as well as other aspects of cognitive functioning, are influenced by the ability to postpone gratification.

7. In order to amplify the investigation of the effects of some of the aforementioned variables, it was decided to study these phenomena in groups of children with markedly different cultural backgrounds. Three groups of children -- one of middle-class background, another composed of Negro, disadvantaged children, and a third selected from two orthodox Jewish parochial schools where they had been given early academic training and subjected to rather severe discipline, were among those who served as subjects. All were in the five to seven year age range, the age when conservation of number has been found to develop.

Use of these groups facilitated the study of some of the aforementioned issues and introduced still others. Does the early academic training received by the parochial school children have a generalized effect upon their differentiation ability? Does this early training foster a more abstract attitude so that the factor of meaningfulness is of lesser importance in their learning efficiency? Conversely, is the degree of investment in the materials around which learning takes place of greater importance for the less disciplined, disadvantaged children? Do the disadvantaged children possess less, and the parochial school children more, tolerance for delay of gratification? Thus systematic cultural variation was introduced to augment the effect of individual differences in order to highlight the influence of some of the variables under study.

Hypotheses

Stated in hypothesis form, this study was concerned with the following

issues:

1. Conservation of number is most highly related to level of differentiation of other, non-numerical magnitudes, but is also positively related to non-magnitudinal aspects of differentiation and to self-differentiation.
2. Conservation of aggregates small enough to be intuitively or immediately grasped occurs prior to conservation of larger aggregates.
3. Conservation is more easily achieved when the objects comprising an aggregate are relatively homogeneous, but different from the components of the aggregates with which it will be compared.
4. Conservation of difference in number is learned earlier than conservation of equivalence in number.
5. Conservation of number is learned earlier for significant objects than for neutral objects.
6. Conservation of number develops more rapidly and more fully in those children for whom the tolerance for delay of gratification is greatest.
7. At the age when conservation of number begins to develop, the following differences may be expected among groups of white middle-class children, Negro underprivileged children, and Jewish parochial school children:
 - a) Parochial school children will manifest a higher level of differentiation ability.
 - b) The discrepancy in conservation performance between meaningful and neutral objects will be smallest in the group of parochial school children and greatest in the disadvantaged group.
 - c) The parochial school group will show the greatest tolerance for delay gratification, and the disadvantaged group the least.

METHOD

Subjects

Two experiments employing different but overlapping procedures were conducted in order to gather data pertaining to all of the hypotheses.

Experiment I was conducted with children from diverse school backgrounds, in order to include a test of hypothesis #7, concerned with predicted differences in the dependent variables as a function of class and experiential background. Three groups of boys from both the kindergarten and first grade levels were studied: a group of predominantly white middle-class children attending two public schools in a middle-class neighborhood, a group of Negro underprivileged children attending a public school in a slum neighborhood, a group of children of predominantly lower-middle-class background randomly selected from two orthodox Jewish parochial schools. There were 24 Ss in each of the three kindergarten and first grade groups except the middle-class first grade sample of Ss which numbered 26. At the time of testing virtually all of the kindergarten Ss ranged in age from 5.3 to 6.3 years, and all of the first grade Ss from 6.3 to 7.3 years.

Experiment II was not concerned with the effects of cultural variation, but it developed that the two schools from which Ss were selected were so different that this variation in background is noted below. Ss were obtained from the first grade classes of two public schools in a middle-class neighborhood currently undergoing considerable deterioration. The boys from one of the schools (P.S. 814) were predominantly of white middle-class background; those from the second school (P.S. 888) were racially more mixed and of somewhat lower socio-economic status. A combined total of 98 first grade boys, 44 from P.S. 888, and 54 from P.S. 814 constituted the subject sample for Experiment II. Table 1 summarizes the composition of experimental groups in

Table 1

SUMMARY DESCRIPTION OF SUBJECT POOL

Subject Group	School	n	n
		Kindergarten (5.3-6.3 yrs.)	First Grade (6.3-7.3 yrs.)
<u>Experiment I</u>			
Middle Class	P.S. 887 + P.S. 852	24	26
Disadvantaged	P.S. 880	24	24
Parochial School	DSY + ESY	<u>24</u>	<u>24</u>
	TOTAL	72	74
<u>Experiment II</u>			
Lower Middle Class	P.S. 888		44
Middle Class	P.S. 814		<u>54</u>
	TOTAL		98

both experiments.

Because Experiment I was in part concerned with the effect of variation of cultural background, subject groups will be designated as: middle-class group, disadvantaged group, and parochial school group, in order to distinguish them in terms of cultural variable. In Experiment II, however, where the cultural background factor was not specifically studied, subject groups will be identified by their school numbers -- P.S. 888 and P.S. 814.

The exclusive use of boys as Ss in the present study was dictated by the results of recent studies which report important new data regarding psychological differences between boys and girls. In the light of these findings the traditional practice of routinely pooling test data obtained from boys and girls, and regarding them as indistinguishable from each other, would be unwise. While it would have been interesting to study sex differences in the variables under study, this would have required the number of Ss to be doubled. Since so large an increase in sample size was not feasible, only boys were studied.

Test Materials

1. Conservation Objects

The conservation materials consisted of miniature trucks and blocks of varying size, shape and color. The number and quality of these objects were determined by the experimental conditions in which they were employed, as follows:

A. Large-Small (See Hypothesis #2)

Large condition: Each row contained 7 trucks (or blocks), or one row contained 7 and the other 9.

Small condition: Each row contained 3 trucks (or blocks), or one row had 3 and the other 5.

B. Homogeneous-Heterogeneous (See Hypothesis #3)

Homogeneous condition: All of the trucks (or blocks) were identical.

Homogeneous-within condition: All of the trucks (or blocks) in one row were exactly the same, and identical to, but larger than those in the other row.

Heterogeneous condition: All of the trucks (or blocks) in both rows varied in color, size and design.

C. Equivalent-Different (See Hypothesis #4)

Equivalent condition: Each row consisted of 3 trucks (or blocks) (3/3); or of two rows of 7 (7/7).

Different condition: One row consisted of 3 trucks (or blocks), and one of 5 (3/5); or one row consisted of 7 trucks and one of 9 (7/9) trucks (or blocks).

D. Significant-Neutral (See Hypothesis #5)

Significant condition: The objects were miniature trucks.¹

Neutral condition: The objects were wooden blocks which were cut to the shape of rectangular prisms, and matched with the trucks for size and color.

To illustrate the above, if S was assigned the large/homogeneous-within/equivalent/significant condition, he was shown two rows of 7 trucks each. All of the trucks in one row were alike, and identical to but larger than all of the trucks in the other row.

The instructions for the conservation of equivalence trials² were:

After E arranged the trucks (blocks) in two parallel rows of equal length and number, he said: "Look at these rows of trucks (blocks). Are there more trucks (blocks) in this row, or in this row, or are there the same number in both?" After S gave

-
1. The trucks were obtained from the Matchbox series, a group of well designed and constructed trucks of great visual appeal.
 2. Appropriate modifications were made for the conservation of difference condition.

correct reply¹ E said, "Yes, there are the same number of trucks (blocks) in both. Now watch what I do." E extended one row of trucks (blocks) so that it was longer than the other. "Now, which row has more trucks (blocks) -- does this row have more trucks (blocks) (E points), or does this row have more trucks (blocks) (E points)? Or is there the same number in both?"

2. Differentiation Tests (See Hypothesis #1)

A. Differentiation of other, non-numerical magnitudes: a series of item sets was constructed, in which S was to designate which of two objects was of greater magnitude with respect to a particular dimension, where the objects also varied in a related dimension. The variation in the related dimension was such that it presented conflicting cues, e.g., if S was asked which of two balls was larger, it might be arranged so that the smaller was demonstrably heavier. The final score was the number of items answered correctly. The following item sets were employed:

1) Depth vs. width: the materials here employed were a set of cardboard boxes of varying size whose dimensions approximated 3" x 4" x 6". Two circular holes, varying in diameter from $\frac{1}{2}$ " - $1\frac{1}{2}$ " were cut on one side of the box, and a cylindrical cardboard tube (from 1" to 3" deep) with a circular floor was inserted in each hole and connected to the side of the box. Two such boxes were constructed, such that the diameter of one of the two holes was always approximately twice that of the other, and the depth of the smaller hole was always more than twice that of the larger. A third box, which was employed in the control condition, was constructed such that the deeper hole was also larger. In each of three boxes both the differences in diameter and depth were clearly visible. The control condition was presented as the second of three trials. In each instance, S was asked: "Which hole is

1. All Ss did give the correct reply here.

deeper?"

2) Thickness vs. length: there were two items in which two pieces of rope and two screws were presented in pairs, one member of each pair being clearly thicker but shorter. S was asked: "Which rope (screw) is thicker?" (Where necessary, the word "fatter" was used to clarify the meaning of "thicker.")

3) Height vs. width: a set of cardboard containers in the shape of rectangular or square prisms was constructed, with height, width and length varying from 1" to 6". Boxes were presented in pairs such that one was taller, the other wider. Four trials were given. In the first two trials, S was asked: "Which box is taller?"; in the following two, S was asked: "Which box is wider?" (Again the word "fat" was used to clarify the meaning of width where necessary.)

4) Age vs. height: a set of photographs was obtained depicting a younger (age ranged from 15-22 years) but visibly taller person standing next to an older (age ranged from 58-70 years) but shorter person of the same sex. Ss were asked which of the two people was older on some trials, and which of the two was taller on others.

Two control conditions were employed. In one, a pair of drawings of the heads of a middle-aged man and an elderly bearded man was presented. There were in this instance no cues regarding relative height, but ample cues for discriminating age. This pair was included to determine if S could use cues relating to age in the absence of data pertaining to height.

The other control condition contained a picture of a demonstrably older, taller man standing next to a shorter, younger man. This was to establish that some Ss were not incorrectly using greater relative height as an indication of lesser relative age, thereby inadvertently responding correctly to

the items.

In all, eight trials were administered, the first two of which presented the control stimuli. The experimental conditions were presented in the next six trials. Ss were asked "Which person is older?" in the first five trials, and "Which person is taller?" in the last three.

B. Differentiation of non-magnitudinal environment

1) Picture-Vocabulary Test: a 12-item test was constructed in which each item presented pictures of three objects belonging to the same class (the three objects were similar both perceptually and conceptually) but could be differentiated from the other two in terms of a more specific referent. For example, one item consisted of pictures of three balls: a football, a baseball and a basketball. In each instance, S was required to point to the appropriate object among the three as the examiner identified it by its specific referent. For example, S was asked: "Show me the baseball." The test was scored in terms of the number of items answered correctly. The objects whose pictures constituted the 12 items of the test are given below; the object which was to be identified is underlined.

- | | | |
|--------------------|----------------|--------------|
| 1. bed | hammock | <u>crib</u> |
| 2. vase | <u>cup</u> | glass |
| 3. gloves | <u>mittens</u> | socks |
| 4. <u>tent</u> | barn | shack |
| 5. chair | bench | <u>stool</u> |
| 6. <u>sailboat</u> | steamer | rowboat |
| 7. lady's hat | <u>cap</u> | fedora |
| 8. <u>wagon</u> | sled | wheelbarrow |
| 9. parrot | chicken | <u>duck</u> |
| 10. sheep | <u>camel</u> | donkey |

- | | | |
|----------------|--------------|-----------------|
| 11. cannon | <u>rifle</u> | pistol |
| 12. basketball | football | <u>baseball</u> |

2) Children's Embedded Figures Test (CEFT): patterned after the work of Gottschaldt, and Witkin's adaptation of embedded figures to the study of psychological differentiation, this test was developed by Karp and Konstadt (1963). It consists of a set of discrimination figures shown separately which S must then find embedded in a set of 25 test figures, each of which constitutes an item of the test.

C. Differentiation of the self: each child was asked to "Draw a person, draw the best person you know." The test was scored according to procedures developed by Harris (1963), based on the work of Goodenough (1926). An adaptation of the Harris scoring system which focussed on those aspects of the child's drawing which reflected the differentiated quality of self-perception correlated so highly ($r = .96$ with 20 cases selected at random) that it was abandoned in favor of the more universally employed Harris scoring system. While this test is generally used to provide an index of intelligence, its content appears more directly related to self-differentiation. An inter-scorer agreement coefficient of .90 was obtained with this scoring system.

3. WISC Vocabulary Subtest

This test was included to provide an estimate of general intelligence and verbal ability. In addition it was expected that these scores would clarify the discriminant validity of the differentiation measures.

4. Tolerance for Delay of Gratification

Four measures of tolerance for delay of gratification were obtained -- two attributed and two behavioral. The attributed measures were obtained by telling the child a story in which the hero is given the choice between

an immediate lesser gratification and a delayed greater gratification, and S is asked to indicate which of the two alternatives the hero would choose. The two stories employed to obtain the attributed measures are given below:

Now I'm going to tell you a story with some parts missing and I'd like you to fill them in. Once there was a little boy named _____. _____ was walking down the street and he passed a toy store window all full of toys. Now right in the middle he saw one toy he liked best of all. What do you suppose it was?

Yes, he really wanted a _____ because that was his favorite toy. Is it yours?

Well, he went home and asked his mommy and daddy if he could have a _____ for a present. They said "yes." So the next day they all went to the store to get a _____, but when they got there and looked in the window, do you know what had happened? The _____ was gone.

They went inside to ask the toy man what had happened and he said he'd just sold the last _____. "But," he said, "I can get another one in next week. Do you want to wait for a _____ or take a different toy now?" Well, _____ thought and thought, but didn't know what to do. He didn't know whether to take a different toy now or wait a while for a _____. Let's see if we can help _____. What should he do -- wait for a _____ or get a different toy now?

* * * * *

Once there was a boy, and his name was _____. Well, it was Saturday afternoon at _____'s house, and his daddy was home. And _____'s daddy said to _____, "Let's do something together, what would you like to do? Would you like to go to the zoo or to the circus?" Where did _____ want to go? _____ "OK," said _____'s daddy. "How would you like to go, by car or by subway?" So they took the _____ and got to the _____. When they got inside they saw a man selling things to eat -- popcorn, chocolate and soda. _____ thought he might like to have something, what do you think he chose _____? _____ asked his daddy if he could have some _____ and his daddy said "Yes, here is some money, go and buy some _____. When _____ asked the man for _____ the man said "I only have small _____ now, but by the time the _____ is over I will have big ones again." So _____'s daddy asked him, "What would you rather do? Have a big _____ later or a small _____ now?" What did _____ choose? A small _____ now, or a big _____ later?

The behavioral measures of tolerance for delay were group administered in each of the classes from which Ss were originally drawn, approximately one to three months after the completion of individual testing. The children were offered, in two separate sequences, a choice between a lesser immediate prize, and a greater delayed prize. It was made clear that the prizes would be awarded according to their personal choice. Their choices were indicated privately by way of a secret ballot. They were offered one roll of life-savers¹ today, or two tomorrow, and in the second instance, one rubber ball with an attached elastic band today, or two the following day.

5. Conservation Pictures

A set of Conservation Pictures was constructed and administered to help clarify the nature of the processes underlying conservation of number. These pictures consisted of cards on which sets of paper seals of familiar objects, e.g., birds, flags, etc., were pasted in rows, resembling the arrangements of the final phase of the conservation problem. They represent a task similar to but different in certain essential features from the conservation of number problem. In effect, the Conservation Pictures present the final stage of the conservation of number problem, i.e., the presentation of the rows in rearranged form such that differences in length of the line of objects do not accurately reflect differences in number. The Conservation Pictures always present a conflict between spatial and numerical cues; unlike the conservation problems, there is no previous unambiguous establishment of the actual numerical relationship between rows. A set of 11 such cards of seals (items A - K), arranged in rows of varying length, was constructed and administered to each S. The arrangements of these rows are presented in

1. In order to observe dietary rules, bars of chocolate-covered peanut chew were used instead of lifesavers in the parochial schools.

schematic form in Figure 1.

Procedure

Experiment I

This experiment was primarily designed to study the effects of the significant-neutral and large-small factors upon conservation of number in children of diverse cultural backgrounds, and the relationship of conservation of number to differentiation ability and tolerance for delay of gratification.

The design of the conservation trials requires detailed presentation. All Ss were given seven trials. Every S initially received four conservation of equivalence trials, two of which presented the large condition (7/7), and two the small condition (3/3), and correspondingly, two of the significant condition, and two of the neutral condition. Ss were assigned at random to each of four sequences presenting the first four trials. These four sequences (of trials #1 - 4) are presented below:

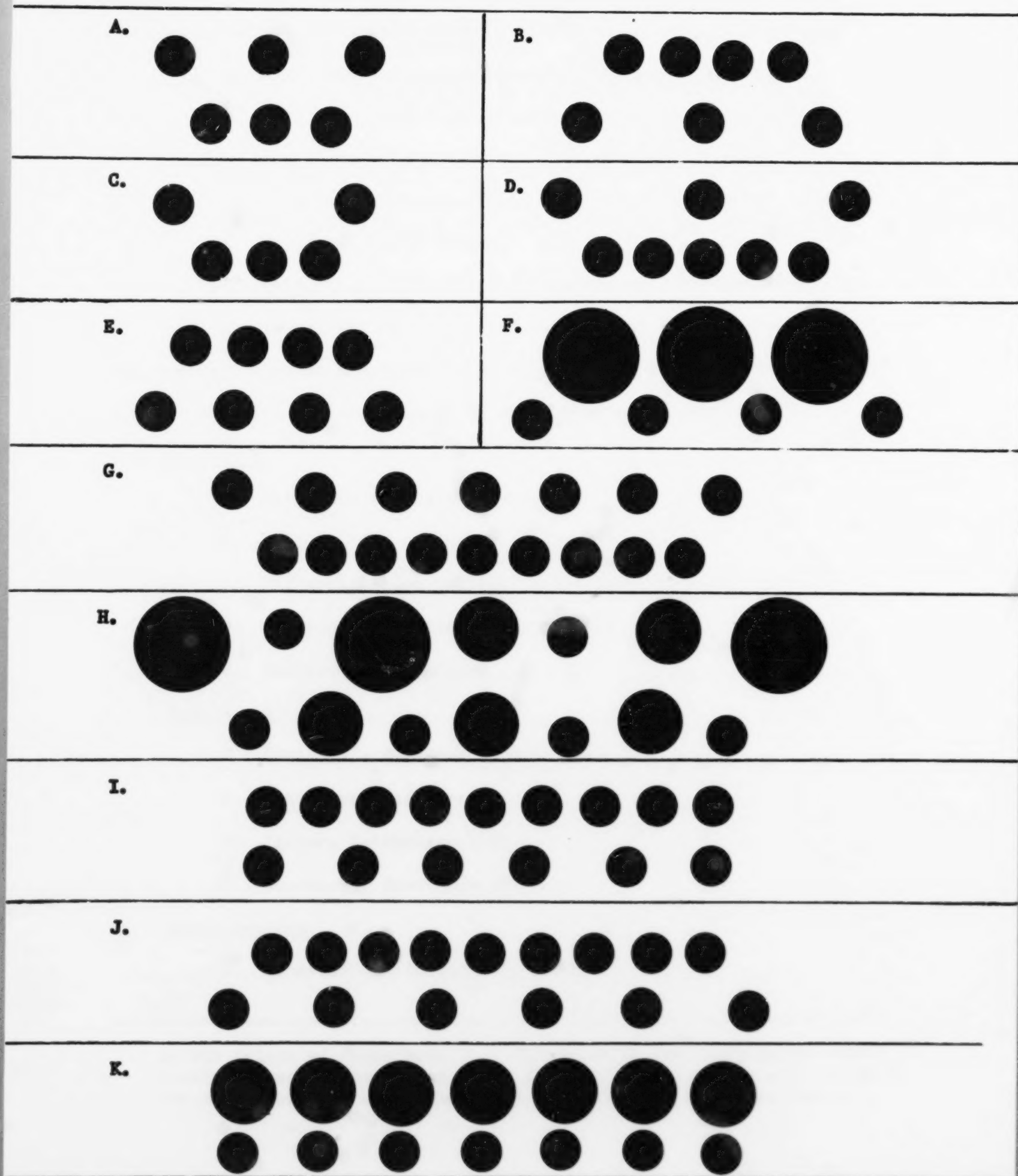
- a) significant 3/3,¹ significant 7/7, neutral 3/3, neutral 7/7
- b) significant 7/7, significant 3/3, neutral 7/7, neutral 3/3
- c) neutral 3/3, neutral 7/7, significant 3/3, significant 7/7
- d) neutral 7/7, neutral 3/3, significant 7/7, significant 3/3

Trials #5 and #6 presented conservation of difference problems, always under the large-neutral condition. In trial #5, the row of seven was extended so that it equaled the row of nine in length, whereas in trial #6, the row of seven was extended so that it was longer than the row of nine.

In trial #7, two rows of equal length, each containing seven neutral objects, were presented. S was told to count one row, and then was asked how many there were in the other.

1. 3/3 denoted that two rows of three objects each were used, i.e., the small conservation of equivalence condition. Correspondingly, 7/9 would denote the large conservation of difference condition.

SCHEMATIC PRESENTATION OF CONSERVATION PICTURE ITEMS



The seven conservation trials administered in Experiment I are summarized below. It should be noted that these seven trials were always given¹, but that the order of the first four trials varied.

- 1) small/equivalent/significant: two rows of 3 trucks
- 2) large/equivalent/significant: two rows of 7 trucks
- 3) small/equivalent/neutral: two rows of 3 blocks
- 4) large/equivalent/neutral: two rows of 7 blocks
- 5) large/different/neutral: one row of 7 blocks and another of 9
- 6) large/different/neutral: one row of 7 blocks and another of 9
- 7) large/different/neutral: one row of 7 blocks and another of 9

The complete list of measurement procedures which were used in Experiment I are listed below in the sequence in which they were administered:

Session I

- A. Tolerance for Delay Story (Toy)
- B. Conservation of Number Trials (#1 - 7)
- C. Differentiation of Other Magnitudes Subtests
- D. Tolerance for Delay Story (Candy)
- E. Conservation Pictures

Session II

- F. Children's Embedded Figures Test
- G. WISC Vocabulary Test
- H. Picture Vocabulary Test
- I. Goodenough Draw-A-Person Test

Group Session

- J. Behavioral Tolerance for Delay

1. In all trials of Experiment I, a variation of the homogeneous-within condition was employed, i.e., all the trucks (blocks) in one row were the same, but of a different color from those in the other row.

Summary of Experiment I: by providing data with regard to differentiation ability and tolerance for delay gratification, as well as conservation performance under significant-neutral and small-large conditions, with Ss of varying cultural backgrounds, the experiment provided data with regard to Hypotheses #1, 2, 5, 6, 7 and supplementary data with regard to Hypothesis #4.

Experiment II

Although it provided additional data with regard to the relationship of conservation to tolerance for delay and self-differentiation, this experiment was fundamentally concerned with the effects of the following conditions upon conservation of number performance: homogeneous/homogeneous-within/heterogeneous, equivalent/different and significant/neutral. To obtain all possible combinations of one level for each factor would have required the presentation of 12 ($3 \times 2 \times 2$) different experimental conditions. This was deemed too many to present to such young children, and only half of these combinations were presented in six conservation trials. The six trials were arranged so that they constituted three consecutive pairs in which each of the three homogeneous-heterogeneous conditions -- homogeneous, homogeneous-within, heterogeneous -- was presented. Each pair was made up of one conservation of equivalence and one conservation of difference problem, and each employed significant objects once, and neutral objects once. Thus these six trials presented each of the levels of the homogeneous-heterogeneous factor twice, and each of the levels of the equivalence-difference and the significant-neutral factors three times. Twenty-four different sequences of these six trials which presented varying combinations of these 12 levels were employed to counterbalance the order of presentation. Complete counterbalancing of trial sequences was not achieved, i.e., each condition was not represented in each trial sequence equally often. Ss were randomly assigned to these 24

different trial sequences.

All six of the above mentioned trials involved large aggregates. Two additional conservation trials presenting the small condition were included. Half the Ss received the small condition as their first trial, the other half as their second trial. All Ss received the second and final small condition last. The first of these two small trials exactly duplicated the condition of the first large trial, except for the size of aggregate. The second and last of these small trials duplicated the conditions of the last large trial. To summarize the conservation trial sequence in Experiment II, all Ss were given eight conservation of number trials. Trials #1 or #2 and #8 presented the small condition and trials #1 or #2 and #3 - 7 presented the large condition. An example of one of the 24 trial sequences which was employed is given below:

- 1) small/homogeneous/equivalent/significant: two rows of 3 trucks
(all trucks identical)
- 2) large/homogeneous/equivalent/significant: two rows of 7 trucks
(all trucks identical)
- 3) large/homogeneous/different/significant: one row of 7 trucks
one row of 9 trucks
(all trucks identical)
- 4) large/homogeneous-within/equivalent/neutral: two rows of 7 blocks
(all blocks identical
except larger in one row)
- 5) large/homogeneous-within/different/neutral: one row of 7 blocks
one row of 9 blocks
(all blocks identical
except larger in one row)
- 6) large/heterogeneous/equivalent/significant: two rows of 7 trucks
(all trucks different)
- 7) large/heterogeneous/different/significant: one row of 7 trucks
one row of 9 trucks
(all trucks different)
- 8) small/heterogeneous/different/significant: one row of 3 trucks
one row of 5 trucks
(all trucks different)

Only one individually administered experimental session was employed. The procedures are cited here in the same sequence in which they were originally administered:

- A. Tolerance for Delay Story (Toy)
- B. Conservation Trials
- C. Tolerance for Delay Story (Candy)
- D. Goodenough Draw-A-Person Test
- E. Conservation Pictures Administration
- F. Behavioral Tolerance for Delay (group administered)

Summary of Experiment II: Experiment II overlapped with Experiment I in that it provided data with regard to the significant-neutral, large-small and equivalent-different factors, and the role of tolerance of delay. In addition, it provided an assessment of the homogeneous-heterogeneous factor. Hence it served to evaluate Hypotheses #2, 3, 4, 5, 6 and elements of #1.

RESULTS

Although the experimental design of this study called for the introduction of most experimental conditions to each S so as to provide for intra-subject comparisons of the variables under study, and thereby avoid inter-subject variation in the analysis of findings, it became evident that behavior on all trials was non-independent of the preceding trials. This consideration led to a focus of interest on the trial #1 data. For this reason data have been routinely analyzed and presented in two ways: 1) for all trials, and 2) for trial #1 exclusively. Because performance on all trials subsequent to the first appeared to be so profoundly influenced by the response to the initial trial, the effects of some of the experimental variables have been measured in terms of whether they led to uniform patterns of success or failure on succeeding trials. (See in particular the results of the study of the large-small continuum.) Finally, it should be noted that it has been more convenient to conduct statistical analyses of differences between experimental groups on data based upon trial #1 exclusively because the frequencies there encountered described independent events. Frequencies based upon data obtained from all trials are a composite of inter-subject and inter-trial/intra-subject performance, which present special difficulties of analysis and interpretation.

The presentation of the findings is organized in terms of the first six hypotheses. Data pertaining to the seventh hypothesis, associated with predicted differences among the diverse samples, will be incorporated within these six sections, wherever relevant.

1. Differentiation

Hypothesis #1:

Conservation of number is most highly related to level of differentiation of other, non-numerical

magnitudes, but is also positively related to non-magnitudinal aspects of differentiation and to self-differentiation.

Data Source: Experiment I, n = 146.

The assessment of differentiation ability was conducted in Experiment I, and studied in relation to conservation of number data which had been gathered during a preceding session. The conservation data, which will be reported in greater detail in later sections dealing with other hypotheses, were characterized by large individual differences and substantial improvement during the course of development from kindergarten to first grade. Many children at both age levels were able to respond correctly to all of the diverse conservation of number problems put before them, while others could solve none of them.¹ At the kindergarten level approximately one third of the children could be termed conservers, whereas more than half of the first graders were successful with these problems.

A. Differentiation of other, non-numerical magnitudes: the ability to make the following differentiations between magnitudes was assessed:

width vs. depth
length vs. thickness
height vs. width
age vs. height

Only the findings with regard to the age-height distinction are presented in tabular form, because all but one of the 146 Ss were able to respond correctly to all of the problems concerned with differentiations involving width-depth, length-thickness, height-width. This indicates that mastery of the distinctions between certain interrelated magnitudes will

1. In the text which follows, children who succeed on all conservation problems presented to them are termed conservers, those who fail all problems are called non-conservers. Those who did not perform uniformly are known as mixed conservers.

occur prior to the development of conservation of number. Whether or not these five and six year old children were able to distinguish between the number and spatial encompassment of aggregates, they were all capable of differentiating depth from width, length from thickness, and height from width as measured in the present study. The inability to conserve quantity is not accompanied by any generalized incapacity to differentiate among magnitudes.

Mastery of the distinction between age -- the only non-physical magnitude included in the array which was studied -- and height has not yet been achieved to a comparable degree, by this age. Regardless of whether they were asked to indicate who was taller or who was older, a considerable number of children designated the taller but younger figure when confronted with a picture of a taller but younger person standing beside a shorter, older person. In other words, the difference in height dominated the response. Almost half of the kindergartners and more than a third of the first graders gave at least one incorrect response to this item set. Table 2 presents performance on these differentiation problems in relation to conservation performance, for each school and age group considered separately. There is a positive, low relationship between conservation and differentiation in the kindergarten groups. The correlations tend to be considerably higher for the first grade group, in spite of the lower variability caused by the low ceilings of both tests. By far the strongest relationship between these two variables was found in the first grade, middle-class and parochial school groups. At the first grade level, the fact of whether or not S made an error in the age-height differentiation series, correlated as highly with conservation as any of the established psychological tests included in the differentiation battery.

RELATIONSHIP BETWEEN DIFFERENTIATION (AGE-HEIGHT) AND CONSERVATION
OF NUMBER

Proportion of Ss Answering Differentiation Items Incorrectly
According to Conservation Performance

Kindergarten (5.3-6.3 yrs.)				First Grade (6.3-7.3 yrs.)			
Conservation Performance ¹ (Trials 1-6)	Number of Differentiation Items Answered Incorrectly			Conservation Performance (Trials 1-6)	Number of Differentiation Items Answered Incorrectly		
	0	1	>1		0	1	>1
<u>Middle Class Group</u>				<u>Middle Class Group</u>			
+ (n=8)	5/8	1/8	2/8	+ (n=18)	15/18	3/18	0/18
Mx (n=9)	6/9	1/9	2/9	Mx (n=6)	6/6	0/6	0/6
- (n=7)	4/7	1/7	2/7	- (n=2)	0/2	2/2	0/2
TOTAL				TOTAL			
FREQUENCIES	15	3	6	FREQUENCIES	21	5	0
$r^{\wedge} = .09$				$r = .45^*$			
<u>Disadvantaged Group</u>				<u>Disadvantaged Group</u>			
+ (n=5)	3/5	1/5	1/5	+ (n=8)	6/8	1/8	1/8
Mx (n=11)	7/11	3/11	1/11	Mx (n=12)	8/12	1/12	3/12
- (n=8)	3/8	3/8	2/8	- (n=4)	2/4	0/4	2/4
TOTAL				TOTAL			
FREQUENCIES	13	7	4	FREQUENCIES	16	2	6
$r = .17$				$r = .24$			
<u>Parochial School Group</u>				<u>Parochial School Group</u>			
+ (n=9)	4/9	0/9	5/9	+ (n=17)	10/17	0/17	7/17
Mx (n=7)	3/7	2/7	2/7	Mx (n=1)	0/1	0/1	1/1
- (n=8)	2/8	0/8	6/8	- (n=6)	0/6	1/6	5/6
TOTAL				TOTAL			
FREQUENCIES	9	2	13	FREQUENCIES	10	1	13
$r = .12$				$r = .45^*$			
<u>All Groups Combined</u>				<u>All Groups Combined</u>			
+ (n=22)	12/22	2/22	8/22	+ (n=43)	31/43	4/43	8/43
Mx (n=27)	16/27	6/27	5/27	Mx (n=19)	14/19	1/19	4/19
- (n=23)	9/23	4/23	10/23	- (n=12)	2/12	3/12	7/12
TOTAL				TOTAL			
FREQUENCIES	37	12	23	FREQUENCIES	47	8	19
$r = .10$				$r = .37^{**}$			

1. + = All conservation items right.
Mx = Mixed conservation performance.
- = All conservation items wrong.

$\wedge$ Signs reflected.

* $p < .05$ (one-tailed test)

** $p < .01$ (one-tailed test)

B. Differentiation of the non-magnitudinal environment

1) Picture Vocabulary Test: although this test was, for the most part, too easy for the children participating in this study (and requires refinement and lengthening), most of the children did not receive perfect scores, and considerable variation in performance was found. Table 3 presents the mean Picture Vocabulary score for conservers, for the mixed performers and for non-conservers. Differences between conservers and non-conservers in mean Picture Vocabulary score were small, and not always in the predicted direction. There was no strong relationship discernible between conservation performance and Picture Vocabulary for any group of children, according to school group or age, most of the correlation coefficients being essentially of zero magnitude. It should be noted that the order of mean differences among school groups in Picture Vocabulary test scores did not correspond to group mean differences in conservation ability, as had been predicted. The parochial school groups' Picture Vocabulary scores ranked last, yet their conservation performance was high.

2) Children's Embedded Figure Test (CEFT): the ability to overcome an embedded context, as it relates to conservation of number, is indicated in Table 4 in the form of mean scores on the CEFT for conservers and non-conservers. Differences in performance on the Embedded Figures Test between conservers and non-conservers were small and not always in the expected direction in the kindergarten groups. More substantial differences between conservers and non-conservers, in accord with expectations, were obtained with the first graders. Although higher for the first grade groups than those in the kindergarten, the correlations between CEFT and conservation never exceeded .30.

It is of some interest that in three of the six experimental groups, the mixed conservers scored lower than the non-conservers. Insofar as a

Table 3

RELATIONSHIP BETWEEN DIFFERENTIATION (AS MEASURED BY PICTURE VOCABULARY TEST)
AND CONSERVATION OF NUMBER

Mean Picture Vocabulary Test Score According to Conservation
Performance

Subject Group	Conservation Performance ¹ (Trials 1-6)			Total	r (Conservation x Pict.Vocab.)
	+	Mx	-		
<u>Kindergarten (5.3-6.3 yrs.)</u>					
Middle Class	11.71 (n=7)	11.67 (n=9)	11.00 (n=7)	11.48 ¹ (n=23)	.34
Disadvantaged	9.40 (n=5)	9.70 (n=10)	10.14 (n=7)	9.77 (n=22)	-.14
Parochial School	8.11 (n=9)	8.58 (n=7)	7.71 (n=7)	8.13 (n=23)	.10
TOTAL	9.62 (n=21)	10.08 (n=26)	9.62 (n=21)	9.79 (n=68)	-.02
<u>First Grade (6.3-7.3 yrs.)</u>					
Middle Class	11.56 (n=18)	11.33 (n=6)	12.00 (n=1)	11.52 (n=25)	-.02
Disadvantaged	11.28 (n=7)	11.00 (n=11)	11.50 (n=4)	11.18 (n=22)	-.11
Parochial School	9.65 (n=17)	11.00 (n=1)	9.50 (n=6)	9.67 (n=24)	.03
TOTAL	10.74 (n=42)	11.11 (n=18)	10.45 (n=11)	10.79 (n=71)	.01

1. + = All conservation items right.
Mx = Mixed conservation performance.
- = All conservation items wrong.

This notation will apply to conservation performance in the tables which follow.

[/] Maximum score = 12

Table 4

RELATIONSHIP BETWEEN DIFFERENTIATION (AS MEASURED BY CEFT)
AND CONSERVATION OF NUMBER

Mean CEFT Score According to Conservation
Performance

Subject Group	Conservation Performance (Trials 1-6)			Total	r (Conservation x CEFT)
	+	Mx	-		
<u>Kindergarten (5.3-6.3 yrs.)</u>					
Middle Class	9.00 (n=7)	7.56 (n=9)	8.14 (n=7)	8.17 (n=23)	.21
Disadvantaged	6.40 (n=5)	5.90 (n=10)	7.14 (n=7)	6.41 (n=22)	-.16
Parochial School	7.67 (n=9)	7.43 (n=7)	6.43 (n=7)	7.22 (n=23)	.17
TOTAL	7.81 (n=21)	6.88 (n=26)	7.24 (n=21)	7.28 (n=68)	.06
<u>First Grade (6.3-7.3 yrs.)</u>					
Middle Class	14.06 (n=18)	8.67 (n=6)	11.00 (n=1)	12.64 (n=25)	.29
Disadvantaged	10.43 (n=7)	8.82 (n=11)	7.25 (n=4)	9.05 (n=22)	.18
Parochial School	9.35 (n=17)	8.00 (n=1)	6.83 (n=6)	8.67 (n=24)	.29
TOTAL	11.55 (n=42)	8.72 (n=18)	7.36 (n=11)	10.18 (n=71)	.30**

** $p < .01$ (one-tailed test)

mixed conservation performance is indicative of an approach to problem solving which is even less systematic than the approach of those who fail consistently, this unexpected pattern of performance on the CEFT may be understood in terms of the greater demand for thoroughness and systematization of scanning required by the CEFT.

C. Differentiation of the self: Table 5 presents mean Goodenough-Harris raw scores in relation to conservation. Although conservers outperformed non-conservers in all of the groups, differences in mean scores were seldom large. Correlations between Goodenough-Harris raw scores and conservation performance were low. Self-differentiation, as measured by the Goodenough-Harris analysis of a drawing of a person, does not appear to be a good predictor of conservation of number ability. Or, if these scores are interpreted more conventionally, as measures of intelligence, they suggest that conservation of number is unrelated to intelligence.

Intercorrelations among the differentiation measures and group means are given in Tables 6 and 7 respectively. The intercorrelation data indicate less commonality among these measures than was expected, and suggest that differentiation is not a univocal ability. A number of substantial interrelationships among differentiation measures exists but no consistent pattern of intercorrelation emerges. Part of this unevenness is undoubtedly attributable to deficiencies of measurement, but in addition it calls for further analysis of the conceptual status of differentiation as a cognitive trait.

The parochial school children did not excel in differentiation ability as had been predicted. In fact, they ranked last or close to last on all of the differentiation measures; the older parochial school group ranked

Table 5

RELATIONSHIP BETWEEN SELF-DIFFERENTIATION (AS MEASURED BY DRAW-A-PERSON TEST)
AND CONSERVATION OF NUMBER

Mean Draw-a-Person Test Score According to Conservation Performance

Subject Group	Conservation Performance (Trials 1-6)		Total	r (Conservation x Draw-a-Person)
	+	-		
<u>Kindergarten (5.3-6.3 yrs.)</u>				
Middle Class	15.83 (n=6)	12.71 (n=7)	15.14 (n=22)	.27
Disadvantaged	13.40 (n=5)	12.00 (n=7)	12.57 (n=21)	-.04
Parochial School	14.89 (n=9)	13.57 (n=7)	13.57 (n=23)	.03
TOTAL	14.74 (n=19)	12.76 (n=21)	13.77 (n=66)	.07
<u>First Grade (6.3-7.3 yrs.)</u>				
Middle Class	18.39 (n=18)	18.00 (n=1)	18.16 (n=25)	.10
Disadvantaged	20.71 (n=7)	17.67 (n=3)	20.62 (n=21)	.06
Parochial School	15.50 (n=16)	10.83 (n=6)	14.78 (n=23)	.31
TOTAL	17.66 (n=41)	13.60 (n=10)	17.78 (n=69)	.13
P.S. 888*	21.29 (n=14)	15.87 (n=15)	18.23 (n=44)	.18
P.S. 814	19.17 (n=24)	17.88 (n=8)	18.09 (n=54)	.13
TOTAL	19.95 (n=38)	16.57 (n=23)	18.15 (n=98)	.15

* For Experiment II data, Conservation Performance was based on trials 1-8.

Table 6

INTERCORRELATIONS OF DIFFERENTIATION TEST SCORES

Subject Group	Kindergarten (5.3-6.3 yrs.)				First Grade (6.3-7.3 yrs.)			
	Pict. Vocab.	CEFT	Diff. (Age-Ht.)	Draw-a- Person	Pict. Vocab.	CEFT	Diff. (Age-Ht.)	Draw-a- Person
<u>Middle Class</u>								
CEFT	.05	—			.40*	—		
Diff. (Age-Height)	.17	.07	—		.21	.16		
Draw-a-Person	.40*	.30	.40*	—	.41*	.49**	.17	—
WISC Vocabulary	.60**	-.08	.09	.02	.53**	.55**	.30	.61**
<u>Disadvantaged</u>								
CEFT	.59**	—			-.07	—		
Diff. (Age-Height)	.34	-.07	—		.57**	.32	—	
Draw-a-Person	.34	.18	.27	—	.17	.20	.39*	—
WISC Vocabulary	.34	.33	.40*	.57**	.47*	.11	.42*	.15
<u>Parochial</u>								
CEFT	.25	—			.39*	—		
Diff. (Age-Height)	-.05	.06	—		.02	-.05	—	
Draw-a-Person	-.11	.25	-.11	—	.19	.31	.20	—
WISC Vocabulary	.76**	.03	-.25	-.22	.25	.54**	.50**	.48**
<u>TOTAL</u>								
CEFT	.34**	—			.34**	—		
Diff. (Age-Height)	.26*	.02	—		.38**	.25*	—	
Draw-a-Person	.25*	.28*	.20*	—	.34**	.33**	.32**	—
WISC Vocabulary	.58**	.21*	.18	.34**	.49**	.49**	.51**	.39**

* $p < .05$ (one-tailed test)** $p < .01$ (one-tailed test)

Table 7

SUMMARY OF GROUP PERFORMANCE ON CONSERVATION AND DIFFERENTIATION TESTS AND RELATED MEASURES

Subject Group	Conservation of Number 1,2	Conservation Pictures Test Mean Score	Differentiation Scores				WISC Vocabulary Test Mean Score
			Picture Vocabulary Test Mean Score	CEFT Mean Score	Draw-a-Person Test Mean Score	Differentiation Age-Height: No. of Ss Answering (0, 1, >1) Items Incorrectly	
<u>Experiment I</u>							
<u>Kindergarten (5.3-6.3 yrs.)</u>							
Middle Class	8 9 7	8.08	11.48	8.17	15.14	15 3 6	16.52
Disadvantaged	5 11 8	6.71	9.77	6.41	12.57	13 7 4	11.91
Parochial	9 7 8	7.58	8.13	7.22	13.57	9 2 13	11.70
<u>First Grade (6.3-7.3 yrs.)</u>							
Middle Class	18 6 2	9.58	11.52	12.64	18.16	21 5 0	20.64
Disadvantaged	8 12 4	8.96	11.18	9.05	20.62	16 2 6	15.82
Parochial	17 1 6	10.00	9.67	8.67	14.78	10 1 13	13.92
<u>Experiment II</u>							
P.S. 888	14 15 15	7.66			18.23		
P.S. 814	24 22 8	8.94			18.09		

1. Conservation performance is based on trials 1-6 in Experiment I, and trials 1-8 in Experiment II.

2. Discrepancies between frequencies cited in this column and those reporting the differentiation-conservation relationships are accounted for by the fact that a small number of children who received conservation trials were not available for the second session when most of the differentiation measures were administered.

last on all of the differentiation measures. Yet both age groups performed very well on both the conservation of number and Conservation Pictures tests. Clearly, the high level of conservation of number ability they manifested was not attributable to their differentiation ability as measured in the present study. The language deficiencies of the bilingual parochial school children, indicated by their lagging position in Picture Vocabulary scores, were further illustrated by their WISC Vocabulary performance. Here the middle-class children's performance was so superior that their mean WISC Vocabulary score for the Kindergarten group exceeded the means of the other two first grade groups.

The disadvantaged group also performed substantially lower than the middle-class group on most of the differentiation measures. But in this instance their moderately low differentiation scores were accompanied by relatively still lower performance on the conservation of number problems and the Conservation Pictures. Perhaps the most interesting variation in conservation performance between the disadvantaged and parochial school groups was the large difference found in the mixed performance category (see Table 7). In all, only eight Ss from the parochial schools, as compared with almost half of the Ss (23 of 48) from the disadvantaged group, responded in this manner. The difference between the two groups was particularly marked among the older children.

One of the most noteworthy patterns of the disadvantaged children's performance was the substantial gains they made from the kindergarten to the first grade level. This may represent a sampling phenomenon, or it may be an indication of the relatively greater growth induced and supported by school attendance in this group. This was particularly prominent in the Draw-a-Person Test where the older disadvantaged group scored highest of

all groups. The lack of relationship between this measure of self-differentiation and conservation ability is underscored by the high Draw-a-Person scores of the disadvantaged group and their relatively low conservation scores, and by the data of Experiment II. In sharp contrast with the large differences found between P.S. 888 and 814 in conservation of number and conservation picture performance, their mean Draw-a-Person scores were indistinguishable from each other.

In sum, differentiation scores did not closely or uniformly reflect conservation performance. Although substantial intercorrelation among many of the differentiation measures was found, no consistent pattern of such interrelatedness was in evidence. Sizeable differences in conservation ability between the parochial school and disadvantaged children were not mirrored by corresponding differences in differentiation ability. In fact, the rank order of the two groups was often reversed.

2. Large-Small

Hypothesis #2

Conservation of aggregates small enough to be intuitively or immediately grasped occurs prior to conservation of larger aggregates.

Data Source: Experiments I & II, $n = 244$.

In both Experiments I and II, half the Ss were presented with the small condition initially and the other half with the large. In Experiment I, which presented conservation of equivalence problems during the first four trials, there was an alternation of large-small conditions such that trials #1 and 3 were small for half the Ss, and large for the other half. In Experiment II, eight trials were given, only two of which involved small aggregates. For half the Ss, the first and last (eighth) trials presented small aggregates; for the other half the small condition appeared on the second and eighth trials.

The relative frequency of conservation for all trials presenting the large and the small conditions is given for both Experiments I and II in Table 8. Differences in conservation performance on all trials between the large and small conditions were not great, but favored the response to small aggregates. On the whole, these data tend to suggest that the effect of size of aggregate upon conservation of number was not great.

There is compelling evidence, however, that whether the first trial was large or small did have an important influence upon conservation behavior. Table 9 presents first trial conservation performance according to the large-small dimension. It may be observed that large, statistically reliable differences appear when first trial performance is compared for all Ss in Experiment II, and Kindergarten Ss in Experiment I; this effect is not present for first-graders in Experiment I. These data suggest that the large condition does in fact influence the difficulty of the conservation problem, and further, it will be shown that the initial size condition influences performance on subsequent trials as well. The difference between the small and large conditions based on total trials data is obscured by the fact that the Ss were inclined to behave uniformly on all trials (100 out of 144 in Experiment I and 61 out of 98 Ss in Experiment II performed uniformly on all trials). With so little intra-subject variability, the difference between the small and large conditions could not be substantial.

It appears that the first conservation trial is decisive, that a stance is taken with regard to the conservation task upon initial exposure to the first problem, and that the large-small dimension influences this stance. Once this set is established, it is maintained on all subsequent trials despite changes in conservation problem conditions; it tends to be transferred from initial trials involving the large condition to subsequent trials

Table 8

CONSERVATION AS A FUNCTION OF SIZE OF AGGREGATE (ALL TRIALS)

Proportion of Correct Conservation Responses According to
Large-Small Distinction

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Large	Small	Large	Small
<u>Experiment I: Trials 1-4</u>				
Middle Class	.48 (23/48)	.54 (26/48)	.88 (46/52)	.92 (48/52)
Disadvantaged	.56 (27/48)	.58 (28/48)	.63 (30/48)	.73 (35/48)
Parochial School	.54 (26/48)	.58 (28/48)	.71 (34/48)	.75 (36/48)
TOTAL	.53 (76/144)	.57 (82/144)	.74 (110/148)	.80 (119/148)
<u>Experiment II: Trials 1-8</u>				
P.S. 888			.46 (121/264)	.53 (47/88)
P.S. 814			.62 (202/324)	.69 (74/108)
TOTAL			.55 (323/588)	.62 (121/196)

Table 9

CONSERVATION AS A FUNCTION OF SIZE OF AGGREGATE (TRIAL #1)

Proportion of Correct Conservation Responses on Trial #1 According to Large-Small Distinction

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Large	Small	Large	Small
Middle Class	.33 (4/12)	.83 (10/12)	.92 (11/12)	.93 (13/14)
Disadvantaged	.50 (6/12)	.67 (8/12)	.75 (9/12)	.58 (7/12)
Parochial School	.50 (6/12)	.75 (9/12)	.67 (8/12)	.75 (9/12)
TOTAL	.44 (16/36)	.75 (27/36)	.78 (28/36)	.76 (29/38)
	$\chi^2 = 5.77^{\neq}$ (p < .02)		$\chi^2 = .02$ (p > .05)	
P.S. 888			.36 (8/22)	.82 (18/22)
P.S. 814			.38 (10/26)	.82 (23/28)
TOTAL			.38 (18/48)	.82 (41/50)
			$\chi^2 = 18.43$ (p < .01)	

 $\neq \chi^2$ was based on total frequencies.

involving the small condition, and vice versa. Data presenting the first trial condition of those Ss who proceeded to become non-conservers (see Table 10) support this interpretation; they demonstrate the stabilizing effect of the trial #1 condition. For all groups in Experiment II, and the kindergarten groups in Experiment I, conservers reliably more often began with the small condition and non-conservers reliably more often began with the large condition. The first grade Ss in Experiment I, and the mixed conservation groups in both experiments constitute an important exception to this pattern. The mixed groups, by definition, did not behave uniformly on all trials, they were not irrevocably influenced by the first trial condition.

3. Homogeneous-Heterogeneous

Hypothesis #3:

Conservation is more easily achieved when the objects comprising an aggregate are relatively homogeneous, but different from the components of the aggregate with which they will be compared.

Data Source: Experiment II, n = 98.

The overall pattern of findings is one of essential similarity of performance under the three conditions of stimulus variation. The data for the first trial, which presents conservation performance independent of exposure to other conditions, are given in Table 11. Conservation performance as a function of the homogeneous-heterogeneous stimulus condition, for all trials irrespective of sequence, is indicated in Table 12. Differences among the three conditions are not great in either table, but the rank order for conditions changes. The heterogeneous condition produced slightly greater success in conservation than the two forms of homogeneity, upon first exposure. It may be seen that this slight difference is entirely attributable to variation found in response to the large (7/7, 7/9) as

Table 10

SIZE OF AGGREGATE IN TRIAL #1 AS A STABILIZING FACTOR IN
CONSERVATION

Proportion of Ss Showing Uniform Conservation¹ According to
Large-Small Condition of Trial #1

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Large	Small	Large	Small
Middle Class	.25 (3/12)	.67 (8/12)	.83 (10/12)	.86 (12/14)
Disadvantaged	.42 (5/12)	.58 (7/12)	.67 (8/12)	.42 (5/12)
Parochial School	.50 (6/12)	.58 (7/12)	.67 (8/12)	.75 (9/12)
TOTAL	.39 (14/36)	.61 (22/36)	.72 (26/36)	.68 (26/38)
	$\chi^2 = 3.56^{\dagger}$ (p > .05)		$\chi^2 = .01$ (p > .05)	
P.S. 888			.14 (3/22)	.50 (11/22)
P.S. 814			.35 (9/26)	.54 (15/28)
TOTAL			.25 (12/48)	.52 (26/50)
			$\chi^2 = 7.52$ (p < .01)	

Proportion of Ss Showing Uniform Non-Conservation According to
Large-Small Condition of Trial #1

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Large	Small	Large	Small
Middle Class	.67 (8/12)	.08 (1/12)	.08 (1/12)	.07 (1/14)
Disadvantaged	.42 (5/12)	.25 (3/12)	.08 (1/12)	.33 (4/12)
Parochial School	.50 (6/12)	.25 (3/12)	.25 (3/12)	.25 (3/12)
TOTAL	.53 (19/36)	.19 (7/36)	.14 (5/36)	.21 (8/38)
	$\chi^2 = 7.28$ (p < .01)		$\chi^2 = .25$ (p > .05)	
P.S. 888			.55 (12/22)	.14 (3/22)
P.S. 814			.23 (6/26)	.07 (2/28)
TOTAL			.38 (18/48)	.10 (5/50)
			$\chi^2 = 8.84$ (p < .01)	

1. Based on conservation trials 1-4 in Experiment I, and trials 1-8 in Experiment II.

$\dagger$ χ^2 was based on total frequencies.

Table 11

CONSERVATION AS A FUNCTION OF HOMOGENEITY-HETEROGENEITY CONDITION (TRIAL #1)

Proportion of Correct Conservation Responses (Trial #1) According to
Homogeneity-Heterogeneity Condition and Size of Aggregate

	P.S. 888		P.S. 814		Total	
	Large	Small	Large	Small	Large	Small
Homogeneous	.25 (2/8)	.88 (7/8)	.13 (1/8)	1.00 (9/9)	.19 (3/16)	.94 (16/17)
Homog.-Within	.40 (4/10)	.80 (8/10)	.40 (4/10)	.73 (8/11)	.40 (8/20)	.76 (16/21)
Heterogeneous	.50 (2/4)	.75 (3/4)	.63 (5/8)	.75 (6/8)	.58 (7/12)	.75 (9/12)

Table 12

CONSERVATION AS A FUNCTION OF HOMOGENEITY-HETEROGENEITY CONDITION (ALL TRIALS)

Proportion of Correct Conservation Responses (Trials 1-8) According to Homogeneity-Heterogeneity Condition and Size of Aggregate

	P.S. 888		P.S. 814		Total	
	Large	Small	Large	Small	Large	Small
Homogeneous	.44 (39/88)	.57 (17/30)	.61 (66/108)	.78 (28/36)	.54 (105/196)	.68 (45/66)
Homog.-Within	.51 (45/88)	.59 (19/32)	.64 (69/108)	.66 (25/38)	.58 (114/196)	.63 (44/70)
Heterogeneous	.42 (37/88)	.42 (11/26)	.62 (67/108)	.62 (21/34)	.53 (104/196)	.53 (32/60)

opposed to the small (3/3, 3/5) condition. Here it may be that the heterogeneity of aggregates has vitiated the compelling quality of the length of the row. However, when conservation performance on all trials is considered, the heterogeneous condition was slightly less effective than either of the homogeneous conditions.

A trial-by-trial analysis of conservation performance is presented in Table 13. This indicates that differences among the three conditions remain comparatively small until the fifth trial. Here the homogeneous condition is substantially less effective, whereas in the sixth through eighth trials it is the heterogeneous condition which is less supporting of conservation by a substantial margin. The lagging position of the heterogeneous condition when conservation is studied for all trials, seems entirely attributable to this decline in performance in the sixth through eighth trials. This trend, based upon a relatively small number of cases, may be a sampling phenomenon. It is also consistent with the notion that for some children the heterogeneous condition becomes more difficult when it is preceded by a series of trials in which the homogeneous condition has been employed, because the equivalences and differences established during the homogeneous conditions become obscured by the introduction of heterogeneity of materials. Either the heterogeneity serves as a distractor, or the perception of equivalences and differences in previous trials has become embedded within a homogeneous context, so that the heterogeneity interferes with the perception of number. The results of the first trial analysis indicate that heterogeneity does not create difficulties from the outset, suggesting that it is only when it is preceded by homogeneous conditions that it begins to create confusion for some children.

Analysis of first trial conditions of those who became conservers or non-conservers, presented in Table 14, indicates that beginning with the

Table 13

TRIAL X TRIAL CONSERVATION PERFORMANCE ACCORDING TO
HOMOGENEITY-HETEROGENEITY CONDITION

Proportion of Conservation Trials Answered Correctly
(Experiment II: P.S. 888 + 814)

	Trials							
	1	2	3	4	5	6	7	8
Homogeneous	.58 (19/33)	.67 (22/33)	.52 (17/33)	.53 (17/32)	.38 (12/32)	.61 (20/33)	.61 (20/33)	.70 (23/33)
Homogeneous- Within	.59 (24/41)	.56 (23/41)	.49 (20/41)	.64 (18/28)	.57 (16/28)	.66 (19/29)	.62 (18/29)	.69 (20/29)
Heterogeneous	.67 (16/24)	.67 (16/24)	.58 (14/24)	.68 (26/38)	.58 (22/38)	.42 (15/36)	.33 (12/36)	.42 (15/36)

Table 14

HOMOGENEITY-HETEROGENEITY AS A STABILIZING FACTOR IN TRIAL #1
CONSERVATION PERFORMANCE

Proportion of Ss Showing Uniform Conservation According to Homogeneity-
Heterogeneity Condition and Size of Aggregate on Trial #1

Subject Group	Large (7/7, 7/9)	Small (3/3, 3/5)
<u>P.S. 888</u>		
Homogeneous	.13 (1/8)	.50 (4/8)
Homog.-Within	.20 (2/10)	.50 (5/10)
Heterogeneous	.00 (0/4)	.50 (2/4)
<u>P.S. 814</u>		
Homogeneous	.13 (1/8)	.76 (7/9)
Homog.-Within	.30 (3/10)	.36 (4/11)
Heterogeneous	.63 (5/8)	.50 (4/8)
<u>Total</u>		
Homogeneous	.13 (2/16)	.65 (11/17)
Homog.-Within	.25 (5/20) $\chi^2 = 3.10$	.43 (9/21) $\chi^2 = 1.82$
Heterogeneous	.42 (5/12) (p > .05)	.50 (6/12) (p > .05)

Proportion of Ss Showing Uniform Non-Conservation According to Homogeneity-
Heterogeneity Condition and Size of Aggregate on Trial #1

Subject Group	Large (7/7, 7/9)	Small (3/3, 3/5)
<u>P.S. 888</u>		
Homogeneous	.63 (5/8)	.00 (0/8)
Homog.-Within	.60 (6/10)	.20 (2/10)
Heterogeneous	.25 (1/4)	.25 (1/4)
<u>P.S. 814</u>		
Homogeneous	.38 (3/8)	.00 (0/9)
Homog.-Within	.20 (2/10)	.18 (2/11)
Heterogeneous	.13 (1/8)	.00 (0/8)
<u>Total</u>		
Homogeneous	.50 (8/16)	.00 (0/17)
Homog.-Within	.40 (8/20) $\chi^2 = 3.34$	.19 (4/21)
Heterogeneous	.17 (2/12) (p > .05)	.08 (1/12)

heterogeneous condition does not deter conservation. In fact, a greater proportion of the conservers, among those beginning with the more difficult, large (7/7 or 7/9) condition, began with the heterogeneous condition. Relatively few of the non-conservers began with the heterogeneous condition; failure on the initial trial when it was heterogeneous was not followed by failure on the subsequent homogeneous conditions.

Figure 2 presents conservation performance by trial for the mixed conservers in graphic form. The responses of mixed conservers are presented because it is only this group which performed without complete regularity. There is no marked variation in conservation performance as a function of the homogeneous-heterogeneous dimension. Variation in conservation performance appears to be at least as great between adjacent trials presenting identical homogeneous-heterogeneous conditions, as between those in which a change of condition is introduced.

4. Equivalent-Different

Hypothesis #4:

Conservation of difference in number is learned earlier than conservation of equivalence in number.

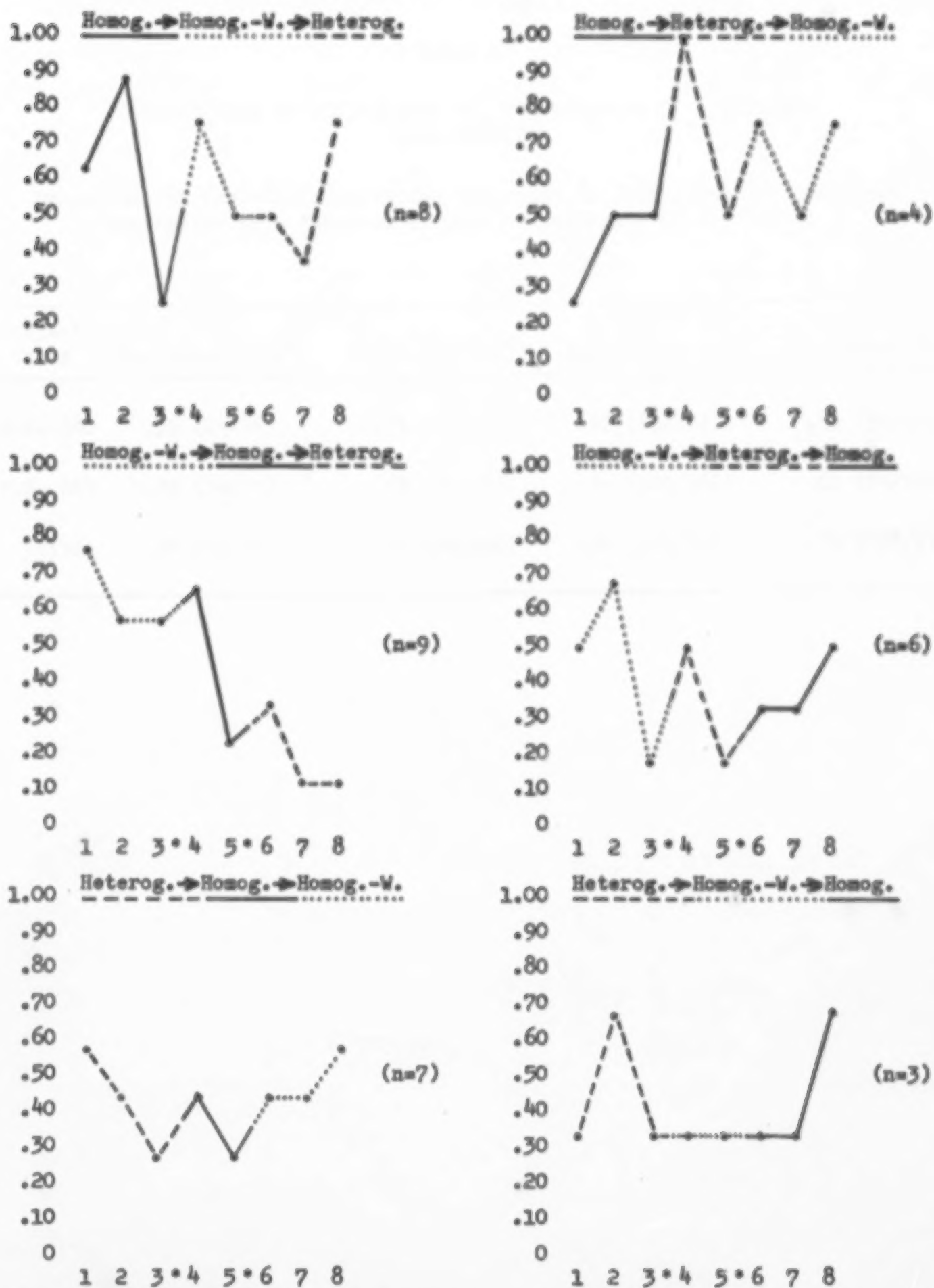
Data Source: Experiment II, n = 98 (Supplementary data provided by Experiment I, n = 146).

Conservation of equivalence and conservation of difference appear to be of equal difficulty; they occurred equally often. Tables 15 and 16 present data regarding conservation of equivalence and of difference for all trials, and for trial #1 respectively. Differences between the equivalence and difference conditions are small in both instances; no discernible difference in difficulty between the two conservation tasks is in evidence.

Among the conservers who received the small condition initially, the relative frequency of equivalence and difference conditions for the first

Figure 2

PROPORTION OF CORRECT CONSERVATION RESPONSES OF MIXED CONSERVATION GROUP,
BY TRIAL NUMBER AND SEQUENCE OF CONDITIONS (P.S. 888 AND 814)



* Indicates points at which a change in homogeneous-heterogeneous condition was introduced. The change in line pattern indicates a connection between different conditions.

Table 15

CONSERVATION OF EQUIVALENCE VS. CONSERVATION OF DIFFERENCE
(ALL TRIALS)

Proportion of Correct Conservation Responses to Equivalent and Different
Aggregates as a Function of Size of Aggregate on All Trials

Subject Group	Equivalent (3/3)	Different (3/5)	Equivalent (7/7)	Different (7/9)
P.S. 888	.55 (24/44)	.51 (23/45)	.47 (62/132)	.45 (59/131)
P.S. 814	.72 (38/53)	.65 (36/55)	.64 (103/162)	.61 (99/162)
TOTAL	.64 (62/97)	.59 (59/100)	.56 (165/294)	.54 (158/293)

Table 16

**CONSERVATION OF EQUIVALENCE VS. CONSERVATION OF DIFFERENCE
(TRIAL #1)**

**Proportion of Correct Conservation Responses to Equivalent and Different
Aggregates as a Function of Size of Aggregate on Trial #1**

Subject Group	Equivalent (3/3)	Different (3/5)	Equivalent (7/7)	Different (7/9)
P.S. 888	1.00 (8/8)	.71 (10/14)	.38 (3/8)	.36 (5/14)
P.S. 814	.83 (10/12)	.81 (13/16)	.38 (3/8)	.39 (7/18)
TOTAL	.90 (18/20)	.77 (23/30)	.38 (6/16)	.38 (12/32)

conservation trial was essentially the same, i.e., equivalence and difference conditions on the first trial led to uniform conservation equally often (see Table 17). With large aggregates, the difference condition slightly (but not reliably) more often was followed by conservation. Correspondingly, non-conservers whose first trial presented a large aggregate, began with a conservation of equivalence trial more frequently. These conserver/non-conserver data, based on large aggregates, suggest that the equivalence condition was slightly more difficult.

The data obtained from conservers and non-conservers, by definition, refer entirely to Ss who performed uniformly on equivalence and difference trials. There was evidence from among the mixed conservation group that a substantial amount of inconsistency of performance in this group was attributable to their inability to deal effectively with both equivalence and difference conditions. The largest inter-trial transition in performance occurred between trials #2 and 3 when the first change in the equivalence-difference condition was introduced. Transitions in both directions (from equivalence to difference, and from difference to equivalence) appeared to be equally difficult. Some children could fairly consistently solve one kind of conservation problem (usually the one they were given first), but were unable to transfer their analysis of the problem from the equivalence condition to the difference condition, and vice versa. For those Ss who succeeded on their initial trial, .67 of their subsequent failures occurred under (equivalent-different) conditions unlike those encountered on trial #1. (If only chance factors were operating this proportion would be .57).

Supplementary data are available from Experiment I. Four conservation of equivalence trials (3/3 and 7/7, alternating in sequence given) always

Table 17

**EQUIVALENCE AND DIFFERENCE AS STABILIZING FACTORS IN TRIAL #1
CONSERVATION PERFORMANCE**

**Proportion of Ss Showing Uniform Conservation According to Equivalence-
Difference Distinction and Size of Aggregate on Trial #1**

Subject Group	Equivalent (3/3)	Different (3/5)	Equivalent (7/7)	Different (7/9)
P.S. 888	.50 (4/8)	.50 (7/14)	.13 (1/8)	.14 (2/14)
P.S. 814	.58 (7/12)	.50 (8/16)	.25 (2/8)	.39 (7/18)
TOTAL	.55 (11/20)	.50 (15/30)	.19 (3/16)	.28 (9/32)

**Proportion of Ss Showing Uniform Non-Conservation According to Equivalence-
Difference Distinction and Size of Aggregate on Trial #1**

Subject Group	Equivalent (3/3)	Different (3/5)	Equivalent (7/7)	Different (7/9)
P.S. 888	.00 (0/8)	.21 (3/14)	.63 (5/8)	.50 (7/14)
P.S. 814	.17 (2/12)	.00 (0/16)	.37 (3/8)	.17 (3/18)
TOTAL	.10 (2/20)	.10 (3/30)	.50 (8/16)	.31 (10/32)

3. Significant-Neutral

Hypothesis #1a

Conservation of number is learned earlier for
significant objects than for neutral objects.

Data Source: Experiments I and II, $n = 148 + 88 = 236$.

preceded two conservation of difference trials (7/9). In the first of these two difference problems, the two rows of unequal number and corresponding unequal length were rearranged to be of equal length, while in the second the rearrangement resulted in the less numerous row becoming longer -- in exactly the manner as the conservation trials in Experiment II. Thirteen of 36 kindergartners who had demonstrated conservation on all four of the preceding equivalence trials, failed both conservation of difference items. Among the first graders, nine of 52 who had succeeded on the four equivalence items, failed at least one of the difference items. Conversely, three of 26 kindergartners who had failed all of the first four items, responded correctly on at least one of the conservation of difference items. One of 13 of the first graders who failed the first four items answered one of the conservation of difference items correctly.

Whether these findings are to be attributed to instability of performance (the existence of mixed groups attests to this instability) or interpreted as demonstrating the existence of separate abilities with regard to conservation of equivalence and conservation of difference, cannot be determined with certainty from the data in this study. It has already been mentioned that an analysis of the performance of mixed conservers in Experiment I indicated that part of their difficulty involved making the transition from conservation of equivalence to that of conservation of difference, and vice versa.

5. Significant-Neutral

Hypothesis #5:

Conservation of number is learned earlier for significant objects than for neutral objects.

Data Source: Experiments I and II, $n = 146 + 98 = 244$.

Both experiments provided for the study of the role of the significance (significant vs. neutral) of objects in conservation of number. Conservation performance as a function of this distinction is indicated both for large and small aggregates, for all trials as well as for only the first trial, in Tables 18 and 19. Differences between the meaningful and neutral condition tend to be small in all school groups, both when performance on all of the trials is considered, or when simply trial #1 scores are examined. Where differences do occur they do not form a consistent pattern, increasing the likelihood that they can be accounted for in terms of sampling variation. Furthermore, there is no evidence of a differential reaction to the significance of conservation objects by disadvantaged and parochial school children as had been predicted.

The influence of the significant-neutral distinction was studied further in another way. After the conservation trials and the Conservation Pictures were administered, those Ss who had failed a substantial number of these items, were shown two additional cards which contained rows of 3 and 5, and 7 and 9, cellophane-wrapped candies pasted in such a manner that the row which contained the fewer candies was longer. These cards were patterned after two cards in the Conservation Pictures which served as prototypes. S was told a brief story about a child who cherished these candies and went to buy some in a store, where he was offered a choice between the two rows of candy for the same amount of money. S was then asked to designate which row the child would choose, again being reminded that the child was interested in having as many as he could get.

Under these circumstances, a number of Ss who had failed corresponding problems among the Conservation Pictures series, now chose the shorter but more numerous row -- in marked contrast with their earlier behavior.

Table 18

CONSERVATION (TRIALS 1-4) AS A FUNCTION OF SIGNIFICANCE-NEUTRALITY
OF OBJECTS

Proportion of Correct Conservation Responses (Trials 1-4)¹ According to the
Significant-Neutral Distinction, and the Size of Aggregates

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Significant	Neutral	Significant	Neutral
<u>Large (7/7, 7/9⁺)</u>				
Middle Class	.46 (11/24)	.50 (12/24)	.88 (23/26)	.88 (23/26)
Disadvantaged	.58 (14/24)	.54 (13/24)	.58 (14/24)	.67 (16/24)
Parochial School	.54 (13/24)	.54 (13/24)	.71 (17/24)	.71 (17/24)
TOTAL	.53 (38/72)	.53 (38/72)	.73 (54/74)	.76 (56/74)
P.S. 888			.42 (56/134)	.50 (65/130)
P.S. 814			.61 (99/162)	.64 (103/162)
TOTAL			.52 (155/296)	.58 (168/292)
<u>Small (3/3, 3/5⁺)</u>				
Middle Class	.58 (14/24)	.50 (12/24)	.92 (24/26)	.92 (24/26)
Disadvantaged	.63 (15/24)	.54 (13/24)	.71 (17/24)	.75 (18/24)
Parochial School	.54 (13/24)	.63 (15/24)	.75 (18/24)	.75 (18/24)
TOTAL	.58 (42/72)	.56 (40/72)	.80 (59/74)	.81 (60/74)
P.S. 888			.39 (18/46)	.69 (29/42)
P.S. 814			.72 (39/54)	.65 (35/54)
TOTAL			.57 (57/100)	.67 (64/96)

1. In Experiment II, trials 1-8 were used.

✱ Conservation of difference trials cited here refer only to Experiment II
(P.S. 888 and 814).

Table 19

CONSERVATION (TRIAL #1) AS A FUNCTION OF SIGNIFICANCE-NEUTRALITY
OF OBJECTS

Proportion of Correct Conservation Responses on Trial #1 According to the
Significant-Neutral Distinction, and the Size of Aggregates

Subject Group	Kindergarten (5.3-6.3 yrs.)		First Grade (6.3-7.3 yrs.)	
	Significant	Neutral	Significant	Neutral
<u>Large (7/7, 7/9^f)</u>				
Middle Class	.50 (3/6)	.17 (1/6)	1.00 (7/7)	.80 (4/5)
Disadvantaged	.50 (3/6)	.50 (3/6)	.83 (5/6)	.67 (4/6)
Parochial School	.33 (2/6)	.67 (4/6)	.50 (3/6)	.83 (5/6)
P.S. 888			.25 (3/12)	.50 (5/10)
P.S. 814			.25 (3/12)	.50 (7/14)
TOTAL	.44 (8/18)	.44 (8/18)	.49 (21/43)	.61 (25/41)
<u>Small (3/3, 3/5^f)</u>				
Middle Class	.83 (5/6)	.83 (5/6)	.86 (6/7)	1.00 (7/7)
Disadvantaged	.83 (5/6)	.50 (3/6)	.50 (3/6)	.67 (4/6)
Parochial School	.67 (4/6)	.83 (5/6)	.67 (4/6)	.83 (5/6)
P.S. 888			.73 (8/11)	.91 (10/11)
P.S. 814			.93 (14/15)	.69 (9/13)
TOTAL	.78 (14/18)	.72 (13/18)	.78 (35/45)	.81 (35/43)

^f Conservation of difference trials cited here refer only to Experiment II
(P.S. 888, 814).

The performance of those Ss who were given these two additional candy trials is given in Table 20 which indicates response outcomes for the two candy trials and the two corresponding Conservation Pictures. It may be observed that performance improved substantially.

Whether this change (especially noticeable in the 7/9 pattern) under the candy card condition is attributable to the greater meaningfulness of the stimulus, to the attentiveness aroused by the story, to the three-dimensionality of the stimulus or some other perceptual feature, or to practice effects, cannot be ascertained. These findings are certainly compatible with the notion that performance on such tasks is affected by a heightened state of attentiveness and aroused interest.

An additional device, in a similar vein, was attempted by one of the examiners, but with only a small number of Ss who had fared poorly on the conservation trials. Upon completion of the conservation of number trials, E arranged the trucks such that a row of nine was shorter than a row of seven (exactly as they appeared after rearrangement in the 7/9 conservation trial) and said, "Pretend you can take one of these lines of trucks home, which line would you want?" Of the 16 Ss asked this question, ten chose the shorter, more numerous line. When they subsequently came upon a similar item in the Conservation Pictures, in which they were asked which row had more objects, all six who had previously chosen the longer less numerous row of trucks, responded incorrectly. Of the ten who had chosen the shorter, more numerous row of trucks, only four answered the corresponding Conservation Pictures item correctly. Here again there is the suggestion that motivational factors can be manipulated to affect performance on problems presenting conflicting cues with regard to quantity.

Hypothesis #9:

Table 20

RELATIONSHIP BETWEEN CONSERVATION PICTURE AND CANDY CARD PERFORMANCE
WITH STIMULUS PATTERN HELD CONSTANT

Conservation Picture (3/5)	Candy Card (3/5)		Conservation Picture (7/9)	Candy Card (7/9)	
	+	-		+	-
+	125	2	+	41	3
-	11	0	-	43	53

Fisher's
Exact
Test

$p > .05$

$\chi^2 = 27.46 (p < .01)$

It appears that tolerance for delay and conservation are related. In order to increase the tolerance for delay and simplify the task, mixed conservation and non-conservation were combined. Consistent with expectations, in the kindergarten group there was almost a complete absence of relationship between conservation and tolerance for delay. Conservators and non-conservators showed equal probability for choosing the immediate lesser prize in favor of the greater delayed reward.

The hypothesized trend of relationship between conservation and tolerance for delay appeared with impressive consistency among the first graders. Virtually all of the school groups, when considered separately or as a total group, show a substantial relationship in the expected direction.

Data pertaining to the attributed measures are presented in Table 23. There was no clear relationship between tolerance for delay and conservation performance in any of the groups of Experiment I. A moderate

6. Tolerance for Delay of Gratification

Hypothesis #6:

Conservation of number develops more rapidly and more fully in those children for whom tolerance for delay of gratification is greatest.

Data source: Experiments I and II, $n = 244$.

The four measures of tolerance for delay consisted of two attributed measures and two behavioral measures. Table 21 indicates the degree of intercorrelation among the four measures of tolerance for delay. It may be observed that only the two behavioral measures were highly interrelated. Because the correlation between the attributed and behavioral measures was low, the relationship of each type of measure to conservation performance will be presented separately.

Table 22 presents behavioral tolerance for delay scores for conservers and non-conservers. In order to increase the frequencies in cells and simplify the tables, mixed conservers and non-conservers were combined. Contrary to expectations, in the kindergarten group there was almost a complete absence of relationship between conservation and tolerance for delay. Conservers and non-conservers showed equal propensity for choosing the immediate lesser prize in favor of the greater delayed reward.

The hypothesized trend of relationship between conservation and tolerance for delay appeared with impressive consistency among the first graders. Virtually all of the school groups, when considered separately or as a total group, show a substantial relationship in the expected direction.

Data pertaining to the attributed measures are presented in Table 23. There was no clear relationship between tolerance for delay and conservation performance in any of the groups of Experiment I. A moderate

Table 21

INTERCORRELATIONS AMONG MEASURES OF TOLERANCE FOR
DELAY OF GRATIFICATION

Correlation (r) Between Behavioral Measures (Ball and Candy Combined)
and Attributed Measures (Toy and Candy Combined)

	<u>r</u>
Total Kindergarten ($n^{\wedge} = 50$)	-.05
Total First Grade (Experiments I & II) ($n = 135$)	.07
Kindergarten and First Grade Combined ($n = 185$)	.05

Correlation (r_{tet}) Between Behavioral Ball Measure and Behavioral
Candy Measure

	<u>r_{tet}</u>
Total Kindergarten ($n = 51$)	.81**
Total First Grade (Experiments I & II) ($n = 141$)	.75**
Kindergarten and First Grade Combined ($n = 192$)	.77**

Correlation (r_{tet}) Between Attributed Toy Story and Attributed
Candy Story

	<u>r_{tet}</u>
Total Kindergarten ($n = 70$)	.22
Total First Grade (Experiments I & II) ($n = 166$)	.31
Kindergarten and First Grade Combined ($n = 236$)	.31*

^ Many Ss were absent for the administration of behavioral measures.

* $p < .05$ (one-tailed test)

** $p < .01$ (one-tailed test)

Table 22

RELATIONSHIP BETWEEN TOLERANCE FOR DELAY (BEHAVIORAL)
AND CONSERVATION OF NUMBER

Proportion of Conservers (+) and Combined Group of Mixed Conservers and Non-Conservers (-) Whose Actual Choice of Rewards Favored Delay (W,W)¹ or Immediate Gratification (N,N)¹

Conservation Perf. x Subject Group	Tolerance for Delay (Behavioral)			r Conserv. x Tol. for Del. (Behav.)
	WW	NW or WN ¹	NN	
<u>Kindergarten (5.3-6.3 yrs.)</u>				
Middle Class	+	.43 (3/7)	.00 (0/7)	.16
	-	.40 (4/10)	.00 (0/10)	
Disadvantaged	+	.00 (0/3)	.33 (1/3)	.00
	-	.27 (3/11)	.36 (4/11)	
Parochial School	+	.38 (3/8)	.25 (2/8)	.00
	-	.42 (5/12)	.33 (4/12)	
TOTAL	+	.33 (6/18)	.17 (3/18)	-.02
	-	.36 (12/33)	.21 (7/33)	
<u>First Grade (6.3-7.3 yrs.)</u>				
Middle Class	+	.41 (7/17)	.24 (4/17)	.34*
	-	.14 (1/7)	.14 (1/7)	
Disadvantaged	+	.43 (3/7)	.29 (2/7)	.46*
	-	.00 (0/9)	.22 (2/9)	
Parochial School	+	.67 (10/15)	.13 (2/15)	.33
	-	.33 (2/6)	.17 (1/6)	
TOTAL	+	.51 (20/39)	.21 (8/39)	.31**
	-	.14 (3/22)	.18 (4/22)	
P.S. 888	+	.50 (5/10)	.20 (2/10)	.40*
	-	.18 (4/22)	.27 (6/22)	
P.S. 814	+	.40 (8/20)	.20 (4/20)	.07
	-	.43 (12/28)	.32 (9/28)	
TOTAL	+	.43 (13/30)	.20 (6/30)	.23*
	-	.32 (16/50)	.30 (15/50)	

1. WW indicates that S chose to wait on both trials (ball and candy).

NN signifies that S preferred to receive both gifts now.

NW or WN indicates that S preferred to wait for a larger gift in one instance and to receive the lesser, immediate reward in the other.

* $p < .05$ (one-tailed test)

** $p < .01$ (one-tailed test)

Table 23

RELATIONSHIP BETWEEN TOLERANCE FOR DELAY (ATTRIBUTED)
AND CONSERVATION OF NUMBER

Proportion of Conservers (+) and Combined Group of Mixed Conservers and Non-Conservers (-) Whose Attributed Choice of Rewards Favored Delay (W,W)¹ or Immediate Gratification (N,N)¹

Conservation Perf. x Subject Group	Tolerance for Delay (Attributed)			r ² Conserv. x Tol. for Del. (Attrib.)
	WW	NW or WN ¹	NN	
<u>Kindergarten (5.3-6.3 yrs.)</u>				
Middle Class	+	.13 (1/8)	.50 (4/8)	-.19
	-	.13 (2/15)	.47 (7/15)	
Disadvantaged	+	.40 (2/5)	.40 (2/5)	.15
	-	.44 (8/18)	.28 (5/18)	
Parochial School	+	.22 (2/9)	.33 (3/9)	.02
	-	.13 (2/15)	.60 (9/15)	
TOTAL	+	.23 (5/22)	.41 (9/22)	-.00
	-	.25 (12/48)	.44 (21/48)	
<u>First Grade (6.3-7.3 yrs.)</u>				
Middle Class	+	.39 (7/18)	.33 (6/18)	-.22
	-	.43 (3/7)	.57 (4/7)	
Disadvantaged	+	.50 (3/6)	.50 (3/6)	-.07
	-	.44 (7/16)	.56 (9/16)	
Parochial School	+	.20 (3/15)	.40 (6/15)	-.01
	-	.29 (2/7)	.14 (1/7)	
TOTAL	+	.33 (13/39)	.38 (15/39)	-.10
	-	.40 (12/30)	.47 (14/30)	
P.S. 888	+	.50 (7/14)	.43 (6/14)	.34*
	-	.38 (11/29)	.38 (11/29)	
P.S. 814	+	.63 (15/24)	.38 (9/24)	.24*
	-	.50 (15/30)	.27 (8/30)	
TOTAL	+	.58 (22/38)	.39 (15/38)	.30**
	-	.44 (26/59)	.32 (19/59)	

1. WW indicates that S chose to wait on both trials (ball and candy).

NN signifies that S preferred to receive both gifts now.

NW or WN indicates that S preferred to wait for a larger gift in one instance and to receive the lesser, immediate reward in the other.

* $p < .05$ (one-tailed test)

** $p < .01$ (one-tailed test)

relationship in the expected direction was found in both groups of Experiment II.

In addition to the moderate but consistent relationships found between conservation and the behavioral measure of tolerance for delay among the older children, these results are interesting in terms of the reversal of response pattern that was evident in the children's reactions to the attributed and behavioral measures. In the hypothetical story situation, it was the members of the disadvantaged group who most frequently suggested that the child would prefer to wait for the greater, postponed gift, while more of the middle-class and parochial school children attributed an interest in more immediate gratification. However, when confronted with the actual opportunity to receive a gift, it was the disadvantaged group who were much more eager to settle for a lesser amount which could be obtained at once.

Since the behavioral measures were derived from group administration involving whole classes, additional data from a great many non-study Ss were obtained. In all, 541 children were given the two behavioral tests. The results from this greatly enlarged sample are summarized in Table 24. The data from all the experimental groups, from girls as well as boys, point to a clear difference between the disadvantaged, and the middle-class and parochial school children. In this situation, there was a strong disposition to seek the immediate lesser reward among the disadvantaged, and a much greater readiness, particularly among the parochial school children, to forego the immediate reward for the larger gain. Cultural background has been found to be decisively related to the behavioral measure of tolerance for delay of gratification.

Table 24

RESPONSES OF ALL CHILDREN (STUDY AND NON-STUDY) TO THE TWO
BEHAVIORAL TOLERANCE FOR DELAY MEASURES

Proportion of Ss Favoring Delay or Immediate Receipt of Prizes

Subject Group	Boys				Girls			
	WW	NN	NW ¹	WN	WW	NN	NW	WN
<u>Experiment I²</u>								
<u>Kindergarten (5.3-6.3 yrs.)</u>								
Middle Class	.45 (13/29)	.45 (13/29)	.07 (2/29)	.03 (1/29)	.40 (16/40)	.38 (15/40)	.08 (3/40)	.15 (6/40)
Disadvantaged	.18 (5/28)	.54 (15/28)	.25 (7/28)	.04 (1/28)	.10 (2/21)	.62 (13/21)	.05 (1/21)	.24 (5/21)
Parochial	.28 (11/40)	.35 (14/40)	.18 (7/40)	.20 (8/40)				
<u>First Grade (6.3-7.3 yrs.)</u>								
Middle Class	.29 (10/34)	.50 (17/34)	.03 (1/34)	.18 (6/34)	.46 (13/28)	.32 (9/28)	.11 (3/28)	.11 (3/28)
Disadvantaged	.18 (10/56)	.52 (29/56)	.11 (6/56)	.20 (11/56)	.11 (4/38)	.74 (28/38)	.08 (3/38)	.08 (3/38)
Parochial	.57 (26/46)	.17 (8/46)	.20 (9/46)	.07 (3/46)				
<u>Experiment II</u>								
P.S. 888	.23 (10/43)	.49 (21/43)	.09 (4/43)	.19 (8/43)	.26 (13/50)	.50 (25/50)	.12 (6/50)	.12 (6/50)
P.S. 814	.42 (22/53)	.30 (16/53)	.11 (6/53)	.17 (9/53)	.43 (15/35)	.29 (10/35)	.09 (3/35)	.20 (7/35)

1. NW indicates that S chose to wait for 2 balls and to have one candy now.
WN indicates that S chose to wait for 2 candies and to have one ball now.
2. The availability of whole classes through group administration greatly enlarged the number of Ss. In the Experiment I groups, total n = 360; in the Experiment II groups, total n = 181.

Conservation Pictures

The Conservation Pictures, in more static form, present a stimulus situation similar to the phase of the conservation problem following the rearrangement of objects to create a conflict between cues pertaining to length and number. On the one hand, the Conservation Pictures task may be regarded as more difficult than the conservation of number task since the two rows were not previously presented in unambiguous fashion, so that their relative number could be determined in the absence of the conflict between length and number. On the other hand, the Conservation Pictures task may be considered less difficult for the child because he does not directly witness the spatial rearrangement which results in the transformation of relationships between length and number; he is not impelled to feel that a change in number corresponding to the change in spatial arrangement must have occurred. These essential similarities, accompanied by important differences, led to the expectation that a comparison between performance on the conservation of number problems and the Conservation Pictures would contribute to a clarification of the conceptual issues involved in conservation of number.

Tables 25 and 26 present the correlations between conservation of number and performance on the Conservation Pictures and the incidence of perfect scores on Conservation Pictures according to conservation of number. In every instance the correlation is high, reaching its greatest magnitude in Experiment II. Were it not for the meager variability in conservation of number scores in some of the subgroups, these correlations undoubtedly would have been higher. Similarly, conservers, far more often than non-conservers, answered all of the Conservation Pictures correctly. It is evident that there is great overlap among the abilities and factors

Table 25

CORRELATION COEFFICIENTS BETWEEN CONSERVATION OF
NUMBER AND CONSERVATION PICTURES

Subject Group	Kindergarten (5.3-6.3 yrs.)	First Grade (6.3-7.3 yrs.)
<u>Experiment I</u> ¹		
Middle Class	.26	.56**
Disadvantaged	.49**	.42*
Parochial School	.56**	.37*
TOTAL	.42**	.43**
<u>Experiment II</u> ¹		
P.S. 888		.55**
P.S. 814		.68**
TOTAL		.63**

1. Conservation of Number Score was based on number of items 1-6 answered correctly in Experiment I, and number of items 1-8 answered correctly in Experiment II.

* $p < .05$ (one-tailed test)

** $p < .01$ (one-tailed test)

Table 26

RELATIONSHIP BETWEEN SUCCESSFUL CONSERVATION PICTURES PERFORMANCE
AND CONSERVATION OF NUMBER

Proportion of Subjects Answering All Conservation Pictures Items Correctly
According to Conservation of Number

Subject Group	Kindergarten (5.3-6.3 yrs.)			First Grade (6.3-7.3 yrs.)		
	+	Mx	-	+	Mx	-
Experiment I¹						
Middle Class	4/8	2/9	2/7	10/18	2/6	0/2
Disadvantaged	2/5	0/11	0/8	3/8	4/12	0/4
Parochial School	2/9	2/7	1/8	11/17	1/1	1/6
TOTAL	8/22	4/27	3/23	24/43	7/19	1/12
Experiment II¹						
P.S. 888				4/14	5/15	0/15
P.S. 814				15/24	5/22	1/8
TOTAL				19/38	10/37	1/23

1. Conservation of Number Score was based on number of items 1-6 answered correctly in Experiment I, and number of items 1-8 answered correctly in Experiment II.

which contribute to the variance of both tasks. The fact that the Conservation Pictures were always administered at a session in which they were preceded by a series of conservation of number trials must have contributed to an enhancement of the intercorrelation between these two tasks. Although children were never informed whether their responses to the conservation of number problems were right or wrong, those who gained insight into the conservation paradigm from exposure to it were thereby fortified in their ability to succeed on the Conservation Pictures.

Table 27 presents a summary of Conservation Pictures performance in relation to presence or absence of conservation of number. It is at once evident that the Conservation Pictures items, in spite of essential similarity of structure, varied greatly in difficulty level. Most of the children were capable of performing effectively on at least some of the items; even most of the non-conservers answered the easier items correctly. Problems C and D posed the least difficulty for all of the children; they illustrate that even non-conservers will see the more numerous row of objects as possessing the larger number in spite of its shorter length. It may be concluded then that under proper circumstances most of these children can distinguish between numerosity and spatial arrangement, even where there is a conflict between these modalities. It indicates further that their previous failure on the conservation of number problems was not attributable to a pervasive verbal misunderstanding regarding the meaning of the word "more." It is still possible that the conservation of number procedure helped to foster confusion regarding the meaning of "more," that E's rearrangement of the objects without changing their number led S to believe that it was the spatial meaning of "more" rather than its numerical meaning which was being referred to.

Table 27

42a

RELATIONSHIP BETWEEN PERFORMANCE ON CONSERVATION PICTURES
AND CONSERVATION OF NUMBER

Subject Group x Conservation Performance		Conservation Pictures Performance										
		A	B	C	D	E	F	G	H	I	J	K
<u>Kindergarten (5.3-6.3 yrs.)</u>												
<u>Middle Class</u>												
Conservers	+	8	7	8	8	7	6	5	4	5	6	8
	-	0	1	0	0	1	2	3	4	3	2	0
Mixed Conservers	+	9	8	9	9	5	8	4	5	6	6	8
	-	0	1	0	0	4	1	5	4	3	3	1
Non-Conservers	+	5	4	5	5	2	6	3	3	4	4	4
	-	2	3	2	2	5	1	4	4	3	3	3
TOTAL	+	22	19	22	22	14	20	12	12	15	16	20
	-	2	5	2	2	10	4	12	12	9	8	4
<u>Disadvantaged</u>												
Conservers	+	5	5	5	5	4	5	3	4	3	5	5
	-	0	0	0	0	1	0	2	1	2	0	0
Mixed Conservers	+	9	7	9	9	1	9	2	0	3	6	10
	-	2	4	2	2	10	2	9	11	8	5	1
Non-Conservers	+	5	6	7	7	0	6	2	3	6	3	4
	-	3	2	1	1	8	2	6	5	2	5	4
TOTAL	+	19	18	21	21	5	20	7	7	12	14	19
	-	5	6	3	3	19	4	17	17	12	10	5
<u>Parochial</u>												
Conservers	+	9	7	9	9	7	8	4	6	6	7	8
	-	0	2	0	0	2	1	5	3	3	2	1
Mixed Conservers	+	7	4	7	7	3	7	3	2	3	4	7
	-	0	3	0	0	4	0	4	5	4	3	0
Non-Conservers	+	6	6	7	7	1	7	2	1	2	4	5
	-	2	2	1	1	7	1	6	7	6	4	3
TOTAL	+	22	17	23	23	11	22	9	9	11	15	20
	-	2	7	1	1	13	2	15	15	13	9	4
<u>All Kindergarten Groups Combined</u>												
Conservers	+	22	19	22	22	18	19	12	14	14	18	21
	-	0	3	0	0	4	3	10	8	8	4	1
Mixed Conservers	+	25	19	25	25	9	24	9	7	12	16	25
	-	2	8	2	2	18	3	18	20	15	11	2
Non-Conservers	+	16	16	19	19	3	19	7	7	12	11	13
	-	7	7	4	4	20	4	16	16	11	12	10
TOTAL	+	63	54	66	66	30	62	28	28	38	45	59
	-	9	18	6	6	42	10	44	44	34	27	13

✓ + = right; - = wrong

Table 27 (cont.)

Subject Group x Conservation Performance	Conservation Pictures Performance											
		A	B	C	D	E	F	G	H	I	J	K
<u>First Grade (6.3-7.3 yrs.)</u>												
<u>Middle Class</u>												
Conservers	+	18	18	18	18	15	18	14	13	16	17	16
	-	0	0	0	0	3	0	4	5	2	1	2
Mixed Conservers	+	6	5	6	6	5	6	4	2	4	5	5
	-	0	1	0	0	1	0	2	4	2	1	1
Non-Conservers	+	2	2	2	2	1	2	0	0	1	1	1
	-	0	0	0	0	1	0	2	2	1	1	1
TOTAL	+	26	25	26	26	21	26	18	15	21	23	22
	-	0	1	0	0	5	0	8	11	5	3	4
<u>Disadvantaged</u>												
Conservers	+	8	8	8	8	8	8	7	5	6	8	7
	-	0	0	0	0	0	0	1	3	2	0	1
Mixed Conservers	+	11	11	12	12	7	12	4	6	10	10	9
	-	1	1	0	0	5	0	8	6	2	2	3
Non-Conservers	+	4	4	4	4	1	4	1	0	2	3	4
	-	0	0	0	0	3	0	3	4	2	1	0
TOTAL	+	23	23	24	24	16	24	12	11	18	21	20
	-	1	1	0	0	8	0	12	13	6	3	4
<u>Parochial</u>												
Conservers	+	17	17	17	17	16	16	14	13	16	16	15
	-	0	0	0	0	1	1	3	4	1	1	2
Mixed Conservers	+	1	1	1	1	1	1	1	1	1	1	1
	-	0	0	0	0	0	0	0	0	0	0	0
Non-Conservers	+	6	4	5	6	6	6	4	2	6	5	5
	-	0	2	1	0	0	0	2	4	0	1	1
TOTAL	+	24	22	23	24	23	23	19	16	23	22	21
	-	0	2	1	0	1	1	5	8	1	2	3

Table 27 (cont.)

Subject Group x Conservation Performance	Conservation Pictures Performance											
	A	B	C	D	E	F	G	H	I	J	K	
<u>First Grade (6.3-7.3 yrs.)</u>												
<u>P.S. 888</u>												
Conservers	+	13	14	14	14	13	13	9	5	11	13	12
	-	1	0	0	0	1	1	5	9	3	1	2
Mixed Conservers	+	12	10	14	12	10	15	6	11	14	8	9
	-	3	5	1	3	5	0	9	4	1	7	6
Non-Conservers	+	4	7	14	13	12	14	2	2	7	9	12
	-	11	8	1	2	3	1	13	13	8	6	3
TOTAL	+	29	31	42	39	35	42	17	18	32	30	33
	-	15	13	2	5	9	2	27	26	12	14	11
<u>P.S. 814</u>												
Conservers	+	24	24	24	24	22	23	22	17	23	24	23
	-	0	0	0	0	2	1	2	7	1	0	1
Mixed Conservers	+	17	17	19	20	16	22	11	7	18	16	19
	-	5	5	3	2	6	0	11	15	4	6	3
Non-Conservers	+	4	4	4	5	5	8	4	4	3	5	7
	-	4	4	4	3	3	0	4	4	5	3	1
TOTAL	+	45	45	47	49	43	53	37	28	44	45	49
	-	9	9	7	5	11	1	17	26	10	9	5
<u>All First Grade Groups (Experiments I & II) Combined</u>												
Conservers	+	80	81	81	81	74	78	66	53	72	78	73
	-	1	0	0	0	7	3	15	28	9	3	8
Mixed Conservers	+	47	44	52	51	39	56	26	27	47	40	43
	-	9	12	4	5	17	0	30	29	9	16	13
Non-Conservers	+	20	21	29	30	25	34	11	8	19	23	29
	-	15	14	6	5	10	1	24	27	16	12	6
TOTAL	+	147	146	162	162	138	168	103	88	138	141	145
	-	25	26	10	10	34	4	69	84	34	31	27

If such a misunderstanding occurred, however, it was specific to the conservation procedure per se, and not indicative of a pervasive confusion regarding the meaning of quantity.

It is noteworthy that Conservation Picture F was also among the easiest of problems. This was the only true control condition; it presented the shorter row as less numerous, while presenting the objects of this shorter row as larger, as occupying more space. The success achieved on this item established the certainty that children had not simply developed the habit of calling the shorter row more numerous in order to succeed in these tasks. Performance on this item also suggested that differences in area are not as easily confused with differences in number.

It was where the Conservation Pictures became more difficult that the greatest discrimination between conservers and non-conservers was achieved. Difficult Conservation Pictures problems were much more difficult for non-conservers. The mixed conserver group usually occupied a position somewhere between the conservers and non-conservers so far as their performance on the Conservation Pictures was concerned.

It is clear that the Conservation Pictures items which at once presented the greatest overall difficulty and distinguished most sharply between conservers and non-conservers, were those which employed large aggregates. But even when smaller aggregates were employed, several items presented problems for the non-conservers, whereas conservers almost uniformly succeeded on these items. It is of interest that the first item, which showed only three objects in each row, was incorrectly responded to by a substantial number of non-conservers. The first two items, in fact, were more difficult than a number of similar succeeding

items for many of the non-conservers. This would suggest that perhaps part of the difficulty was the newness of the task, that the non-conservers were less effective in marshalling their attention and their intellectual resources to cope with a new situation.

Another factor which may have contributed to the non-conservers' difficulty with the first item, is that it presented two rows of objects which were numerically equal but of unequal length. This item, along with item E which presented the same arrangement only with slightly larger aggregates (four) were among the most difficult of the items employing smaller aggregates. It may be that the numerical equality is more difficult to perceive than the numerical difference or, contrary to the implications of the findings with regard to conservation of equivalence and difference, these children in fact were more accustomed to responding in terms of differences than equivalences.

The shift to larger aggregates (7/9) in item G proved troublesome for all Ss, but especially for the non-conservers. This item together with the one which followed it (H) were the most difficult of the Conservation Pictures. In spite of the fact that virtually all Ss were found capable of counting the aggregates, a very large number, including many conservers, could not respond correctly to items G and H. Either they interpreted the problem as one which precluded counting, or as one in which counting was not relevant (an unlikely alternative). Yet size of aggregate per se did not inevitably lead to deterioration of performance. In this regard it is instructive to compare item J (6/9) with G (7/9). Although the lengths of the longer, but less numerous rows were the same in both instances, and the shorter, more numerous rows were exactly the same, item J was much easier for these children. This would suggest that it was not merely

the difference in the length of two rows which entered into the judgment of number, but that children's use of length as an index of number is guided by an interaction of considerations of length, density, and numerical cues. It is not simply that their concept of number is non-numerical, that it is, for example, spatial rather than numerical, but that a continuum exists along which children vary in terms of the degree to which they will be influenced by spatial cues in their judgment of number. Piaget has noted that some children continue to conserve when the less numerous row is made only slightly longer than the other row, but fail when the disparity in length is increased.

It would appear that the more that spatial cues seem to provide information about numerosity, the more they will be relied upon in the judgment of number. This point is further corroborated by the performance of the children on Item I. Here the two rows of unequal number were equivalent in length. But the equivalence in length in this instance was no more compelling than the discrepancy of length in the 9/6 pattern of item J. Other factors -- perhaps the difference in density, or the reluctance to perceive equivalences -- detracted from the spatial cue, and rendered this item less difficult. The final item (K), presented no more difficulties than the earlier, small aggregate problems. Here two rows of seven objects were present in rows of equal length, the size of the objects in one row exceeding those in the other. The successful performance on this item indicates that the length distinction is probably the most important one, and that differences in size of objects presented in a row do not constitute a serious source of distraction or misinterpretation. Item H, however, which presented rows of objects whose size varied within each row, and which presented a discrepancy of length

between these heterogeneous rows of equal number, proved to be most difficult of all. Here the heterogeneity, combined with the children's apparent reluctance to perceive equivalences, resulted in the greatest confusion regarding the judgment of comparative number.

Additional information regarding the relationship between conservation of number and performance on the Conservation Pictures was made available by the seventh conservation trial in Experiment I. This trial was introduced in order to observe the effect of counting on conservation behavior. Although the conservation data produced by this trial were too equivocal to be used, the earlier phase of the procedure yielded some interesting findings. At the outset, E arranged the blocks into two equal rows of seven, established the equivalence of the rows as in previous trials, and then asked S to count one of the rows of blocks. Then S was asked how many of the blocks there were in the other row.

The results of this phase of the procedure are tabulated, along with their relationship to a number of other measures, in Table 28. All of the Ss were able to count the aggregates correctly but they varied in their response to the question regarding the number in the adjacent row. As may be seen in Table 28, a little over half the Ss instantly replied that there were seven, while the remaining Ss went through the process of counting the other row before answering. Most of the conservers responded without counting, and most of the non-conservers chose to count before replying. Instant realization of the equality of number of the two rows distinguished conservers from non-conservers. Conservers were either more capable of making the required deduction, or they were more aware of the numerical equality of the two rows established at the outset.

The difference between the two groups (i.e., between those who counted

Table 28

RELATIONSHIP OF COUNTING BEHAVIOR ON ITEM #7 OF EXPERIMENT I TO PERFORMANCE
ON CONSERVATION OF NUMBER AND CONSERVATION PICTURES

Subject Group	Item #7 Performance	Conservation of Number				Mean Total Conservation Pictures Score $\bar{X}$	Performance on Item G (Conservation Pictures)	
		+	Mx	-	Total		+	-
<u>Kindergarten (5.3-6.3 yrs.)</u>								
Middle Class								
	Did Not Count	5	4	2	11	8.0	3	8
	Counted	3	5	5	13	8.1	9	4
Disadvantaged								
	Did Not Count	4	6	2	12	7.2	3	9
	Counted	1	5	4	10	6.4	3	7
Parochial								
	Did Not Count	7	5	2	14	7.7	5	9
	Counted	2	2	6	10	7.3	4	6
TOTAL								
	Did Not Count	16	15	6	37	7.6	11	26
	Counted	6	12	15	33	7.4	16	17
<u>First Grade (6.3-7.3 yrs.)</u>								
Middle Class								
	Did Not Count	10	4	1	15	9.7	10	5
	Counted	8	2	1	11	9.5	8	3
Disadvantaged								
	Did Not Count	6	7	3	16	8.7	7	9
	Counted	2	5	1	8	9.5	5	3
Parochial								
	Did Not Count	11	1	0	12	10.2	10	2
	Counted	6	0	6	12	9.8	9	3
TOTAL								
	Did Not Count	27	12	4	43	9.4	27	16
	Counted	16	7	8	31	9.6	22	9

and those who did not) in conservation behavior did not extend to their performance on the Conservation Pictures. The two groups were virtually indistinguishable in their mean Conservation Pictures performance. Their performance on item G of the Conservation Pictures, singled out because it presented two large aggregates of unequal number and length (7/9), reversed the pattern of success. In this instance, performance was found to be relatively superior for the group who had counted on the seventh conservation trial. The cautious individual who did not trust to a visual assessment of number, performed more successfully. Thus, despite the close similarity between the conservation of number problems and the Conservation Pictures, the nature of their individual structure differentially supported different modes of response to each task.

DISCUSSION

One of the objectives of the present study was to explore the role of differentiation as a central cognitive factor in conservation of number. It was hypothesized that the ability to distinguish between spatial and numerical cues, the process of differentiation among stimuli, is salient to effective functioning in this sphere. In general these expectations were confirmed, but the correlations between various measures of differentiation and conservation of number tended to be low -- never exceeding .45.

But differentiation ability, defined here as the ability to organize and conceptualize the environment into parts which are structurally and functionally discrete, and to respond differentially to variation in stimulation, does not appear to be as generalized an attribute as was anticipated. Because there was originally some question about the generality of the differentiation concept, two very different measures of generalized differentiation ability were employed in the present study, i.e., the Picture Vocabulary Test and the CEFT. The degree of overlap between measures was less than expected, their intercorrelations ranging from $-.07$ to $.59$. Aside from whatever psychometric deficiencies these two tests may possess, there is reason to believe that actual differences do exist in their true score components.

The Picture Vocabulary Test emphasizes general information level, the ability to recognize a unique verbal designation assigned to specific objects, whereas the CEFT requires the differentiation of pictorial stimuli embedded in larger, more complex, different figures. One is concerned with verbal, symbolic distinctions, the other with overcoming an embedding context which is nonverbal. While it is true that both require that small

distinctions be perceived, they are both influenced by other factors which contribute to their common variances, such as the ability to attend to an array of stimuli, to understand and comply with instructions.

Similarly, in the Draw-a-Person Test it is the human body and its basic attire which is the distinctive content, it is the process of free recall which is involved. S was not asked to recognize a specific distinction, or to find a figure. Rather this task involved emitting a large array of distinctions in the form of an integrated graphic production. The focus was not on the process of distinguishing between stimuli but on the availability of the multiplicity of elements which constitute the whole (person), under circumstances which required this ideation to be expressed graphically.

The age-height discrimination problems, among the differentiation test battery, most closely resembles the task required by the conservation of number problem. Performance on these items did in fact correlate highest with conservation scores. In both instances S had to distinguish between two differences in magnitudes of opposing direction, which customarily vary together. In addition to their specific content, the two tasks differ in that the age-height test neither entails rearrangement of the cues involving the irrelevant magnitude nor pre-establishment of the equivalence with respect to the relevant magnitude. In a sense it is a less contaminated test of differentiation ability than the conservation of number task. The critical issue in the conservation task is the ability to withstand the compelling influence of the rearrangement of the irrelevant cue. The conservation task requires differentiation between the two magnitudes in question, but also skill in processing and retaining information, and relating previous events to the ongoing

situation.

In the light of these considerations it is unrealistic to think in terms of a best measure of differentiation. The differentiation process is ubiquitous; it is involved in the definition of words as well as in virtually all other cognitive tasks. The WISC Vocabulary Test, originally included as a control measure of intelligence, intercorrelated with the components of the differentiation battery as highly as did any of its more specifically designated members. It would seem more useful and realistic to regard differentiation as a process which enters into and interacts with other cognitive processes. The nature of the differentiation component, in any task, varies with its form and content, and the nature of its interaction with its context. Many tasks may be regarded as indices of differentiation but none can be expected to measure it definitively. This conclusion is clearly not in agreement with Witkin (1962), who postulated that differentiation is a specific, measurable trait; nor do the data from the present study confirm the discriminant validity findings reported by him.

The multidimensional quality of differentiation behavior is further illustrated by the data obtained from the parochial school children. The expectation that the parochial school children, by virtue of their unusually early exposure to a formal, didactic school program, would show the greatest differentiation ability, was not borne out. These children ranked last, or close to last, on all of the differentiation tests. They were most deficient, by a large margin, on the age-height differentiation test; their lack of clarity about this distinction was peculiar to this group of children. Yet they performed extremely well on the conservation of number problems and the Conservation Pictures. Variation

in conservation performance within the first grade group did reflect relative ability on the age-height problem ($r = .45$) but, obviously, factors other than these differentiation measures contributed much more decisively to the between-groups variance.

It is of interest that the parochial school group performed well in conservation in spite of obvious language difficulties. Their relative standing was lowest on both the Picture Vocabulary Test and the WISC Vocabulary Test. This was undoubtedly contributed to by their bilingual background; for a large number of these children, English was a secondary language. But before it is concluded that conservation ability is independent of language factors, it should be noted that these children were deficient in English, but not in language ability per se. They did not necessarily lack the mediational resources considered essential for successful problem solving; these were very likely available to them in their major language -- Hebrew or Yiddish.

There has been considerable speculation that conservation performance is frequently an artifact of the child's interpretation of the examiner's instructions, that misinterpretations of language rather than presence or absence of the concept accounts for much variance in conservation behavior. It is in this sphere that the parochial school children's deficiency in English could be expected to serve as an impediment, but there was no clear indication that their conservation performance was impaired by this factor.

The performance of the disadvantaged children, in contrast with that of the parochial school group, was more uniformly low. In addition, it was the disadvantaged children who most often responded with a mixed pattern to the conservation problems. Their performance was more erratic,

more adversely affected by the introduction of changed conditions, there seemed to be less generality or consistency to their conservation behavior. This was in marked contrast to what was perhaps the overly rigid performance of the parochial school children, who seldom responded in mixed fashion to the conservation problems; they responded uniformly correctly or incorrectly.

The single test on which the older disadvantaged children excelled all others -- the Draw-a-Person Test -- was not found to be strongly related to conservation of number. It would be of great interest to determine whether these children do in fact possess a heightened degree of self-differentiation, the expression of which is cultivated by their school experience, or whether they possess special talents in graphic expression at this age by virtue of the nature of their earlier development, or whether they have simply been encouraged to draw and were given more opportunity to engage in this activity because it has been found to be a useful medium for introducing them to school and developing academic skills.

Some of the most striking differences among the culturally diverse groups were obtained with the measures of tolerance for delay of gratification. These data are provocative in spite of the methodological problems which arose. The lack of intercorrelation between the attributed and behavioral measures brought the issue of validity of measurement into focus, and the modest levels of interrelation between attributed measures raise questions about the unidimensionality of the trait and the specificity of measurements.

The marked reversal of response pattern of many of the groups to the attributed and behavioral measures introduces the possibility that responses

to the tolerance for delay stories represent projections. One may speculate that they constitute expressions of attitudes about how they ought to behave, on the part of the disadvantaged children, and expressions of how they wished they could behave, by the parochial school children. Thus, large discrepancies between responses to the behavioral and attributed measures may represent dynamic factors operative in tolerance for delay, rather than mere error variance.

The relationships found between tolerance for delay and conservation of number among the first graders are consistent with the hypothesis that the ability to delay gratification is an important affective forerunner to abstract reasoning. But much more work is necessary before this proposition may be accepted as conclusively demonstrated. A more parsimonious explanation of the findings, and equally plausible, is that tolerance for delay and conservation of number are both reflections of a greater developmental maturity, that their relationship was mediated by another, third common variable rather than indicating a simple cause-and-effect pattern.

The differences in behavioral tolerance for delay scores among the various groups, particularly between the parochial school and disadvantaged groups, are the most clearcut and among the most impressive in the entire study. These results, amplified by the data gathered from the enlarged sample, seem to be identifying very clearcut, and psychologically significant differences among these children. Their magnitude is such, and their implications sufficiently profound, to warrant a great deal more intensive study and elaboration. It remains to be established whether the disadvantaged children really possess so much less tolerance for delay, or whether their scores were more an expression of distrust of the examiner, of some

doubt that the greater gift would in fact be delivered as promised. Other factors which merit further study are the psychological correlates and forerunners of the parochial school children's unusual readiness to forego immediate gratification; much greater elaboration of the cognitive consequences of these apparent differences in attitude toward delay is called for. Kagan's (1963) interest in impulsivity in categorization behavior appears particularly relevant here. Whatever their significance, the findings of this study with respect to tolerance for delay are consistent with the work of Mischel (1958, 1961a, b, 1962, 1964), who has reported a number of provocative relationships employing very similar, simple measures.

Among the stimulus variables whose effect on conservation of number was studied, the size of the aggregate was found to have the greatest impact. There are several points of interest in relation to these findings. First, there was the decisive role of the first trial condition. The small condition was found to be easier when it appeared first. The smallness of the aggregate facilitated recognition of the conservation principle (or at least of the fact that the number of objects in each row was unchanged after their spatial rearrangement), as long as this condition constituted the first exposure to the conservation paradigm. If the small condition was preceded by even a single trial involving the large condition, the facilitating effect of smallness was lost. Problems presenting the large condition were just as easily solved by many children as those presenting the small, provided the small condition was introduced first; problems presenting the small condition were failed along with those involving the large, when the large condition was presented first. Apparently the approach which was adopted to solve the initial problem

could be changed only with difficulty.

This finding points up the considerable degree of perseveration which characterizes performance at this age, and as a corollary, the central importance of the conditions of initial exposure to a problem. It would appear as though subsequent critical appraisal of an initial reaction to a problem is rare, that there is relatively little inclination to modify a response in the light of new experience without the assistance of explicit feedback or guidance. But it is not true that the reaction to the conservation problem was simply a rote, mechanical response to be repeated on each trial. This was demonstrated in Experiment II, where the alternation of conservation of equivalence and of difference problems required a different correct response, i.e., "the same" and "more," on consecutive trials.

The manner in which success on the initial trial, when it presented the small condition, was followed by correct responses to succeeding trials, suggests that a concept had been recognized and applied to a new situation, that there was a transfer of a principle instantly recognized in one situation, to another. Apparently, something about the essential quality of conservation of number is sensed when the first trial presents the small condition, which is then applied to larger aggregates as well, which could not be as easily apprehended had the more difficult, large condition already been experienced and responded to incorrectly. It may be surmised that the number of objects in each row, after rearrangement, could be more easily apprehended under the small condition, that the ease with which the aggregates could be counted at a glance counteracted the effect of the rearrangement and preserved the use of number as the criterion of judgment. But why this same factor ceased to operate when

the small condition was preceded by a trial involving the large condition is unclear.

This differential effect of initial large and small conditions did not occur in all groups, it was found in Experiment II and in the kindergarten groups of Experiment I. There were indications, from their response to the conservation problems and the Conservation Pictures, that the first grade groups in Experiment I were more advanced developmentally than those of Experiment II. This would suggest that the differential effect of large, as opposed to small, conditions is operative among somewhat less mature children. There is no evidence that failure to conserve among the first graders in Experiment I was related to the size of the aggregate. This provides additional evidence that many different factors contribute to non-conservation, and that these factors may become more or less prominent at different developmental levels. The right-wrong evaluation of cognitive responses has too often been interpreted as reflecting a corresponding dichotomy in causation of response.

In terms of their implications for research, these findings regarding first-trial effects strongly suggest that the adoption of a repeated measurements design with children at this age level runs the risk of obscuring important differences between experimental conditions. It is better to accept the burden of individual differences and study large numbers of children than to be misled by the low intra-subject variability which appears to characterize cognitive performance at this age level.

The remaining stimulus factors which were studied -- homogeneous-heterogeneous, equivalent-different, significant-neutral -- did not have a demonstrable effect upon conservation performance. There was a slight

indication that the heterogeneous condition becomes more difficult after S has been exposed to many trials in which homogeneous aggregates have been presented. This is another illustration of the interaction among conditions which appears to be a salient feature of conservation phenomena with this age level. The Conservation Pictures data suggest that a comparison of number between heterogeneous objects arranged in rows is more difficult to make. In this instance, the heterogeneity did not encourage a more cautious approach to the problem, did not prompt S to count each row. Rather it seemed to provoke an assessment in terms of (incorrect) spatial cues. This effect, however, was not in evidence during the conservation of number trials under the conditions they were administered in the present study. Nor was there any indication of a difference between the homogeneous and homogeneous-within conditions as had been hypothesized.

In spite of the fact that children become aware of differences earlier in their development than they do of equivalences, conservation of difference and equivalence occurs with equal frequency in the present study. Once the initial numerical relationship between the two aggregates is established, under the unambiguous conditions of the first phase of the conservation sequence, the fact that this relationship involved equivalence or difference seems to be of no consequence in determining whether the number is conserved. It remains possible, of course, that this factor is operative in the conservation behavior of younger children, at a developmental period when the equivalence relationship has been less firmly established.

Variation of the significant-neutral factor failed to produce corresponding variation in conservation behavior, the significance of objects

appears to have no palpable effect on conservation performance. There is some question, however, in this instance particularly, of whether this factor was studied with sufficient thoroughness. On the one hand, the use of trucks in the significant condition may not have been sufficiently compelling -- there was no prospect of the children's keeping these toys, they remained objects belonging to the experimenter for use in a particular game situation. On the other hand, there was some indication that the blocks, which were employed in the neutral condition, aroused considerable interest among some of the boys and were considered attractive objects by them. In short, the use of blocks and trucks spanned only a narrow band of the continuum of significance or involvement. Strenuous efforts to establish rapport notwithstanding, the dominant feature of the experimental session was probably not the nature of the objects introduced to the children, but the fact that they were being examined by an unknown adult in a school setting. The nature of the objects employed in the test were probably of less significance than the entire framework within which the experience was viewed. More favorable testing conditions, and a more prolonged testing session during which value of objects could be induced, or objects of intrinsic value to S identified, are needed to conduct a more telling experimental test of this issue.

The candy card data gathered after the Conservation Pictures administration offered some indication that judgments made under conditions of greater investment in the objects are more likely to be correct. If nothing else, the heightened attention aroused by such conditions will increase the probability of a correct response by diminishing the adverse effects of inattentiveness or distractability at this age level. The data gathered from the small number of Ss who were told to imagine they

could keep the trucks which served as conservation objects, support this conclusion. It should be noted that these effects were obtained on related but different tasks. No evidence was presented by this study, however, that conservation of number performance is facilitated by this factor.

* * * * *

Conservation of number, as it has usually been defined and measured, gives the appearance of being a unitary trait. The attractiveness of conservation phenomena to cognitive psychologists derives primarily from the fact that it has seemed a terse way of summarizing a complex logical unit and providing an unequivocal method of measuring it at the same time. Experimental results have usually been analyzed dichotomously, in terms of conservers and non-conservers, and some experimenters have sought strategies of inducing or teaching conservation, thereby at least implicitly stating the expectation that the achievement of conservation could be effected by a single specific qualitative transformation in cognitive functioning.

In a sense, the present study departed from this framework; its concern with earlier phases of conservation, with the continuity of its development, constituted a denial that conservation of number was a discrete entity which functioned on an all-or-none basis. However, the results of the study -- the negligible impact of the significant-neutral, homogeneous-heterogeneous, equivalent-different dimensions -- are congruent with a view of conservation as impervious to variation in experimental conditions, as an internal intellectual attitude which either exists or does not exist. Piaget himself refers to "true" conservers, i.e., children who instantly recognize the absurdity of the manipulation of the

conflicting irrelevant cue and immediately comment upon its irrelevance, as though the true essence of this finite concept had been achieved.

Although "true" conservers, as Piaget characterized them, seem to analyze the conservation problem in a completely different way from non-conservers, the conserver/non-conserver dichotomy appears to oversimplify and exaggerate differences in performance. The complex quality of the conservation task has already been noted. To perform as a "true" conserver, one must be able to establish the numerical equivalence between two aggregates, retain the fact of their equivalence, and connect their previous equivalence with the rearrangement of the aggregates so that the manipulation of the conflicting cue is recognized as both irrelevant and misleading. The "true" conserver is capable of performing each of these interrelated tasks, and has achieved an integration of them such that he possesses at least an intuitive awareness of the principle underlying conservation. Other children can conserve but show no signs of insight into the basic principle. They respond correctly to a succession of problems, without any overt recognition of the presence of a single common theme.

Among the non-conservers, a variety of factors may account for their failure. If a child has been prohibited or discouraged from counting, in accordance with many of the procedures of experiments with conservation of number, he may conclude that the numerical criterion of number is not to be used, and hence proceed to judge number in terms of the irrelevant cue, e.g., length, because of misinterpretation of experimental procedures. Similarly, it has been suggested that the child may misinterpret the experimenter's manipulation of the irrelevant cue as an indication that it is this criterion of numerosity which the experimenter is referring

to (Zimiles, 1963). In addition, if the child has not been watching carefully, and sometimes even if he has, he may conclude from the results of the rearrangement of the rows, that the rearrangement actually involved removing or adding some of the objects. If he then counts to make sure, he has removed himself from the class of "true" conservers by virtue of his counting. If he has been discouraged from counting, or is not sufficiently at ease or sufficiently thorough-going to count, and persists in his belief that the rearrangement involved adding or subtracting objects, then he will respond incorrectly. If he was not sure of the previously established equivalence, as apparently was the case for many Ss in Experiment I (judging from their behavior on trial #7 in which they counted the aggregates), he must base his judgment of number exclusively on a comparison of the rearranged rows. Finally, he may respond incorrectly because he is guided more by length than by number in making judgments of comparative number in aggregates. All of these considerations account for failure of one form or another on the conservation problem. They clearly constitute an array of very disparate factors. They need to be considered in relation to the basic characteristics of conservation of number as a cognitive task.

While conservation has been defined and conceptualized primarily in terms of differentiation between magnitudes, the essential feature of the conservation procedure is the witnessing of the rearrangement of the irrelevant cue so that it conflicts with the relevant cue after an initial rendering in which relevant and irrelevant cues were in their usual form of correspondence with each other. The principal element is recognition of the irrelevance of the transformation, so as to be unaffected by it. The process of differentiation defines the purely

conceptual requirements of the conservation task; it leads to the governing principle which underlies problem solution. The ability to withstand the intrusion of a transformation of cue relationships involving an irrelevant dimension is a more molar, more integrative statement of the conservation task. The latter is difficult to categorize in terms of its relationship to the cognitive domain because it is more inclusive. It is, to be sure, a function of the ability to differentiate between conflicting cues, but it is also related to attentiveness, to the distractability of the child, to his ability to remain concerned with one aspect of a stimulus in the face of competing aspects which are more dominant, to his sense of gamesmanship -- the recognition of the interrelationship of the two phases of the conservation procedure and the decoy function of the irrelevant cue, and his awareness of the expectations of adult interviewers.

Thus conservation behavior often represents a response to artifacts. Many of the factors which affect performance are deemed artifactual because they do not involve the conceptual problem posed by the conservation situation. The factors which may contribute to misinterpretations of the task, or inattentiveness to and faulty registering of essential detail, are at least partially independent, at the age level when conservation phenomena are studied, of the salient, differentiation aspect of conservation behavior. Once the differentiation of conflicting cues has been firmly established, as it is in later childhood, the firmness of differentiation ability sharply reduces the possibility of being distracted by more compelling transformations. This is fortified by a number of factors: the increasing prepotency of number as compared with other dimensions, e.g., length, as a criterion for judging quantity,

additional experience with judging aggregates with respect to number while viewing them under varying spatial arrangements -- reinforcing the conclusion that number is independent of geometric properties, more sophistication in problem solving conventions including the use of decoys which help to identify the irrelevance of the conflicting transformed cues. The differentiation aspect of the conservation of number problem is a discrete, clearly definable cognitive element, but it is so enmeshed in a matrix of diverse and semi-relevant response patterns that it cannot serve as the precise cognitive indicator it would appear to be. In view of this complexity, it is questionable whether conservation is as viable a mode of behavior for the experimental analysis of cognition as has been supposed.

While the uniformity of response on all conservation trials, so characteristic of the children in this study, would seem to suggest a solidity and stability of conservation performance, it may at the same time be interpreted as indicating a sterotypy of response and a brittleness of performance. This latter, less sanguine view appears justified by the results of the study of the large-small distinction. These data strongly suggest that for many children whether or not the small condition trial comes first or second is decisive, that the picture of sturdy, continuous conservation, or of a total absence of the ability to conserve, depends upon so tenuous a factor as the sequence of the first two trials.

The fact that a small initial trial is capable of setting off a sequence of different, correct responses to a set of more complex problems suggests that many of these children possess the "cognitive structures," or conceptual framework for effectively meeting this task.

Yet, if they are introduced to a large condition first, they apparently are not capable of invoking this framework to perform successfully. Under such circumstances can the conserver/non-conserver distinction, measured in this fashion, be assigned great significance?

Equally mystifying is the fact that the small condition loses this ability to evoke a conserving attitude once it is preceded by a more difficult (large) condition. Children respond to this item as though it were much more difficult than when it is given first. The inability of the children to use this apparent catalyst unless it appears first raises questions about their mode of cognitive functioning. It suggests that at this age children's reactions to problem solving situations are less organized, less systematic, and less purposeful than those customarily observed in adults. Fluctuations in attentiveness, a lesser concern with connectedness of events, the tendency to persevere, a preoccupation with satisfying the demands of a strange adult, together with a lack of sophistication regarding the meaning of an intellectual problem, are some of the features of these five and six year olds' cognitive behavior, which distinguish it from the more orderly and rational style of adults.

At the same time, this apparent lack of order obscures a conceptual ability which can be activated under appropriate circumstances. Relatively few of the children can be characterized as clearly lacking a particular concept. Although psychologists tend to investigate conceptual thinking in terms of its presence or absence, this does not appear to be a suitable model for studying children's cognition. It is precisely the either-or orientation which seems to be lacking. Concepts are not neatly compartmentalized, nor are contradictions eliminated. As Werner (1926) observed long ago, fusions of concepts exist, and these fusions would

appear to exist in states of dynamic equilibrium, with one aspect and then another assuming momentary dominance. Most of these children did not feel impelled to behave consistently, although there were frequent instances of perseveration. Nor was it as obvious to them as it was to the adult experimenter that they were apprehending a premise upon which they were later to base a deduction. They did not necessarily look at what was "obviously" most important, or choose to register the aspect of an event which would later prove most useful. Yet most of them evince some form of effective problem solving behavior; almost all at one point or another were able to judge numerical aggregates in terms of numerical cues instead of conflicting irrelevant cues. But the degree to which this was systematically achieved varied greatly. It is the cognitive organization of these children, the availability of conceptual schemas and the ability to apply them systematically, rather than their mere presence-absence, which appears to be the important cognitive issue at this developmental level.

The manner in which these children used number further illustrates the discrepancy between their mode of cognitive functioning and that of the adult. It was established that all of the children could count at least from one to seven. But clearly, for the children, counting represented one device for assessing quantity, but not a decisive one. A small number of children even changed the outcome of counting to conform with their perceptual estimate of the two rows. A much larger group simply did not bother to count. Either they did not interpret this task as one which could most easily be met by counting, or it is possible that in some instances more subtlety was attributed to the experimenter and counting seemed too easy and straightforward a way of answering the

question. In any event, the ability to count the aggregates in question, as has been attested to by a great many experimenters, did not assure conserving behavior in these children.

The fact that almost half the children chose to count the other parallel row in response to the question of how many, after they had just counted the first row (conservation item #7, Experiment I), underlines the limited propensity for deduction among these children when they are working with numerical stimuli, and the uncertainty of the pre-established equivalence of the two aggregates prior to the counting. Experiences which were to serve as premises for subsequent conservation deductions, simply were not registered as established, irrefutable facts in the first place. Perhaps it is the absence of very firm anchorage points of previous experiences which render these children so responsive to the contemporaneous stimulus situation.

The Conservation Pictures data provide additional evidence of the discontinuities in the cognitive functioning of these children. Although the correlations between conservation of number performance and Conservation Pictures scores are high, they are far from perfect, and they are undoubtedly inflated by the previous experience with the conservation of number problems, i.e., the variance in Conservation Pictures Test was very likely augmented by the differential experience of success with the conservation of number problems. In spite of the fact that the Conservation Pictures Test is constituted of component parts of the conservation of number problems without the confusing transformation of cue relationships episode, only half of the conservers in both experiments (51 of 103) answered all of the Conservation Pictures correctly. Almost one third of this group (31 of 103) failed at least two of the 11 Conservation Pictures

items, after having succeeded on all the conservation of number problems in which the irrelevance of the conflicting cue of length was established. At the same time five of 58 non-conservers answered all of the Conservation Pictures items correctly.

These discontinuities in cognitive functioning, the apparent failure of these children to use their very recent experiences in a highly similar setting, to recognize the similarities between the events, and their lesser concern for responding with consistency (witness also the mixed conservers) are in evidence throughout this study. On the one hand, many of these children seemed to be responding to each situation anew, as though they were not guided by a backlog of experience with basically similar problems. On the other hand, their responses often seemed automatically triggered by previous trials, without awareness of the change in stimulus conditions. Interspersed among these two diverse patterns, but not always occurring in predictable fashion, was a selective, purposeful response to the environment which exemplified effective cognitive functioning.

Hence it may be concluded that although the distinction between conservation and non-conservation seems clear and substantial, differences between conservers and non-conservers may be slight, and status as a conserver or non-conserver may lack stability. Rather, it would appear that an underlying continuum exists, that a large array of factors may cause failure on the conservation task, and that these factors vary in their conceptual significance. If conservation behavior is to be regarded as a complex of cognitive and stylistic factors, it cannot at the same time be considered a simple conceptual unit. Yet much of the experimental work and discussion concerned with conservation, including upon occasion, the writing of Piaget himself, implies that it involves a single idea,

that it is a conceptual unit which may appear in stages, but constitutes an integral whole. The present analysis points to the instability of performance, the prominence of artifacts, and the multiple cognitive factors that are involved. The ability to conserve number as it is measured in the conventional conservation paradigm, is the resultant of a set of cognitive attitudes involving the gathering and processing of information and an awareness of and sensitivity to their interconnections. Conservation should more properly be regarded as an index of a set of semi-interrelated cognitive attitudes than as a specific articulated concept. This was in fact the status it was assigned by Piaget; conservation data were amassed to illustrate concrete operational thought, conservation performance was used to exhibit and illustrate a form of cognitive orientation.

It is for these reasons that the recent efforts to identify and devise methods for training conservation appear misplaced. If it is true that conservation is a composite of cognitive and semi-cognitive factors, then various training procedures will succeed in overcoming different deterrents to conservation, and many training procedures will be successful, not because of the cognitive growth they foster, but because they succeed in removing artifactual barriers. Most attempts of this nature have had only variable success, as the present analysis would have predicted. Many of these attempts to achieve conservation seem to be based upon an erroneous evaluation of the concept and an overvaluation of the cognitive significance of the specific behavior itself.

More recently, Wallach and Sprott (1964) and Beilin (in press) have reported more successful efforts to teach conservation by emphasizing the reversibility of the rearrangement effects. But, characteristically, the degree of success reported by both

experimenters, employing very similar training methods, were very different. In both experiments it is possible that the principal effect of the training is to communicate to the child which criterion of numerosity the experimenter wished him to apply. In experiments of this type, the critical need is to determine how much real conceptual growth was actually effected by such procedures. The interest of these investigators in the durability of the training, and in the generality of its effect, represent important advances in experimental analyses of cognitive problems through the use of training procedures.

The recent interest in conservation is symptomatic of the quest for simple units of cognition. Yet careful study of any cognitive performance emphasizes its complexity. It would seem more realistic to conduct functional analyses of measures in order to identify their underlying network of cognitive processes than to seek samples of behavior which are themselves irreducible cognitive elements. In the present study, conservation behavior was found to be completely unaffected by a number of stimulus conditions and remarkably sensitive to others. Such extreme effects have been attributed to the mediation of more central, intervening factors. It is the organizing and integrating aspect of cognition which needs to be delineated if complex forms of behavior are to be understood.

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